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CONVERSION OF THE "PRODIGY" TO STEREO

VOLUME 12
NUMBER 10
MAY
1959

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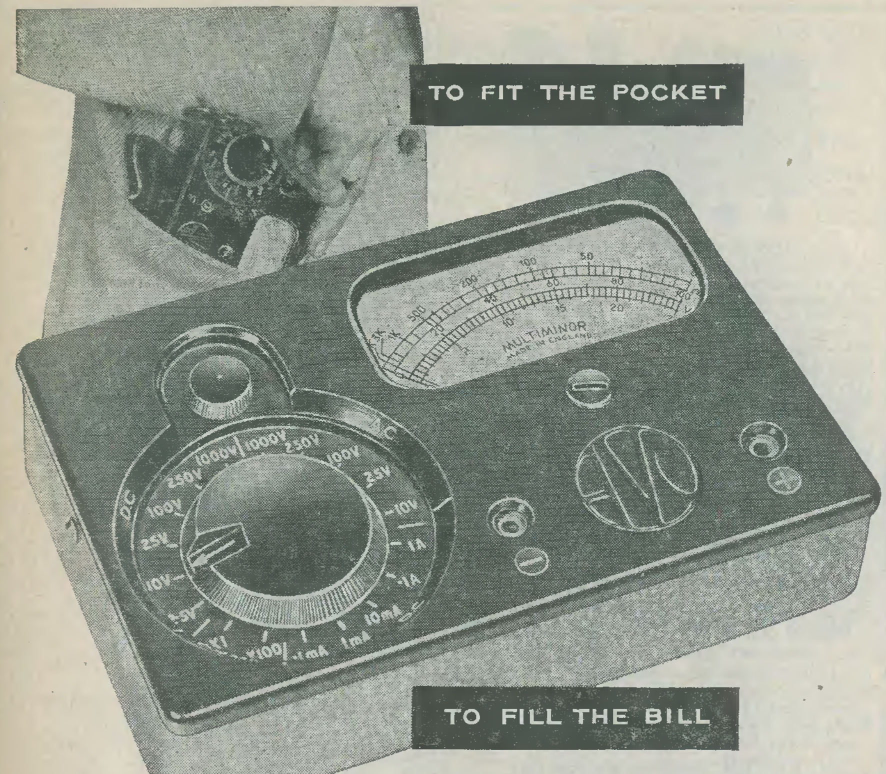

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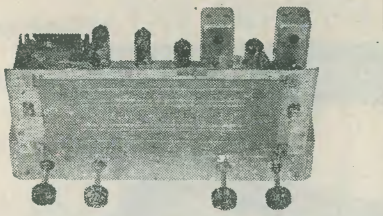

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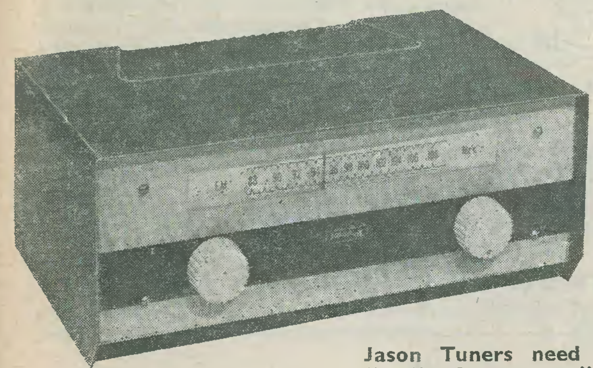

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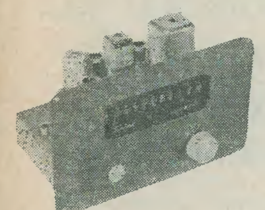

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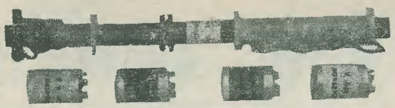

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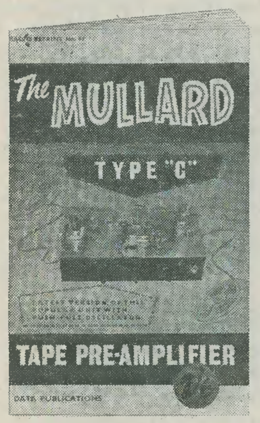

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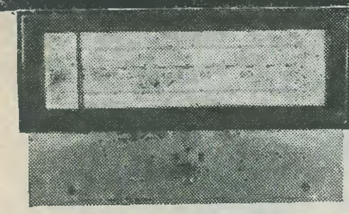

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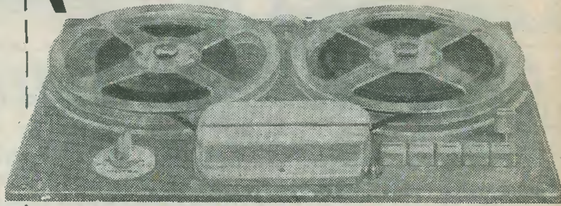

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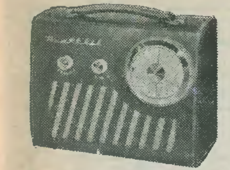

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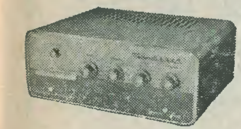

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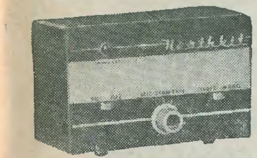

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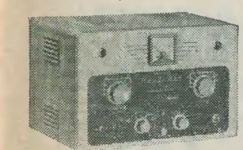

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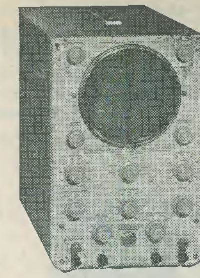

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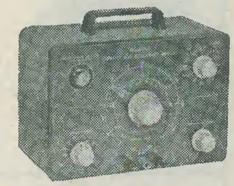

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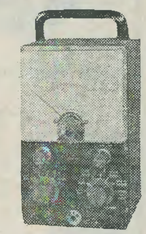

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THE EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should preferably be typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsmen will redraw in most cases, but all relevant information should be included.

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RECORDING

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suggested circuits

No. 102 A Tape Recorder Muting Circuit

AN ANNOYING DISADVANTAGE EVIDENT IN many of the tape recorders available at the time being is that their switching circuits are so arranged that the associated a.f. amplifier comes into operation at the same moment as the capstan motor is switched on. This effect occurs irrespective of whether the recorder is switched to "Playback" or to "Record." If the capstan motor is switched on when the recorder is set to "Playback," the result is that any sound which may happen to be recorded on the tape at the playback head becomes immediately reproduced at continually increasing frequency until the motor achieves full working speed. If the recorder happens to be set to "Record" when the motor is switched on, the results may be even more vexing. This is because any signal passed to the "Record" head during the period in which the motor accelerates is recorded on the tape with artificially increased frequency. As most users of tape recorders will confirm, the final effect, when the tape is played back, is that of a short burst of very high-pitched sound at the commencement of any recording period.

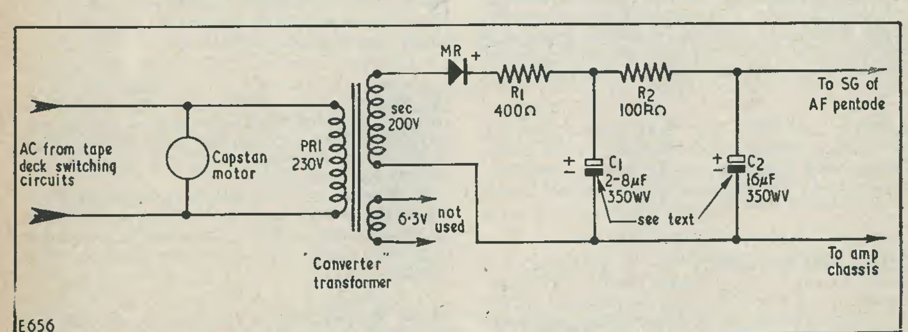
Both these effects mar the enjoyment offered by the recorder. They may be overcome by initially adjusting the amplifier gain control to zero level when the capstan motor is first switched on, and advancing it when the motor has reached normal operating speed, but this complicates the operation of the recorder. A better idea consists of a circuit which automatically mutes the amplifier over the period when the capstan motor accelerates to its full operating speed. A device capable of offering this facility is the subject of this month's article.*

Circuit Operation

A difficulty which has to be overcome in a tape recorder muting arrangement of the type we are considering here is that the capstan motor switching circuits normally handle mains voltages direct, whilst the amplifier circuits are isolated by means of a mains transformer. In consequence, no direct connection may be made between the two parts of the recorder. The introduction to the amateur market some years ago of relatively inexpensive "converter" mains transformers (having h.t. secondaries of 200 volts at 30mA and intended for use with Band III television converters or pre-amplifiers) overcomes this obstacle, and a "converter" transformer is employed in the arrangement which is described here.

The circuit of the muting device accompanies this article, and it functions in the following manner. When the capstan motor is switched on, by applying mains voltage to its terminals via the recorder switching circuits, this mains voltage is simultaneously applied to the primary of the "converter" transformer. An a.c. voltage appears in the transformer secondary and is rectified by the metal rectifier, with the result that a d.c. voltage appears across reservoir condenser C_1. Resistor R_2 and condenser C_2 have a relatively long time constant, causing an appreciable time to elapse before C_2 charges up to its final voltage. The potential across C_2 is applied to the screen-grid of any voltage amplifier pentode (this excludes the output pentode) in the recorder amplifier.

Summing up the operation of the circuit, it may be stated that when the capstan motor is initially switched on the screen-grid of the amplifier pentode fed by C_2 is at zero potential, and the amplifier is, in consequence, inoperative. After a period of time the screen-grid voltage becomes sufficiently high for the amplifier to function and the recorder operates in normal fashion, it having been muted during the time when the capstan motor accelerated to full working speed.



Design Details

There are several points of design which require a little further amplification. The first of these is concerned with the "converter" transformer employed for isolating the motor switching circuits from the amplifier. As was mentioned above, "converter" transformers have secondary windings rated at 30mA. This current rating is considerably higher than is required in this particular application, wherein the requirements of the amplifier screen-grid will almost certainly be less than 1mA. Also, the "converter" transformer will be fitted with a 6.3 volt heater winding which is not needed (unless it be used for a pilot lamp or some similar accessory). It would appear, therefore, that the mains transformer specified has ratings and facilities which are excessive for present circuit requirements, and that it would be preferable to employ a component having a single h.t. secondary with a markedly lower current rating. Should such a transformer be on hand it may, of course, be employed. However, the general availability and relatively low cost of "converter" transformers makes these a much better choice for most constructors.

Rather the same comments apply to the metal rectifier since, here again, it will probably be found cheaper in practice to use a rectifier rated at some 30 to 50mA than it would to employ one rated at a lower current. A good choice of rectifier for this circuit would be a small contact-cooled component of the type which has, like the mains transformer, become popular in television converter or pre-amplifier kits.

In the diagram, reservoir condenser C_1 is specified as having a capacity lying between 2 and 8μF. Due to the low current requirements of the circuit, a capacity of 2μF in this component is quite adequate. Nevertheless, constructors may have available condensers with the more-frequently encountered value of 8μF, and there is no reason why components having this value (or, indeed, any other value between 2 and 8μF) should not be used. Due to the low current drawn by the amplifier pentode screen-grid, C_1 may tend to charge up to peak potential. For this reason it would be preferable to fit a component having a working voltage of 350 at this part of the circuit.

The time constant of R_2 and C_2, on their own, is 1.6 seconds. This constant will,

* Circuits capable of similarly muting the tape recorder amplifier were described in Suggested Circuits No. 35 ("Start" Muting Circuit for Tape Recorders) in *The Radio Constructor* for October 1953. At that time mains transformers of the type which form the basis of the present Suggested Circuit were not available to the amateur, and the previous circuits relied on extra switching contacts or the use of a relay.

however, be modified by the effective non-linear resistance provided between the cathode and screen-grid of the amplifier pentode. Also, since the time constant figure refers to the time in which the voltage across C_2 rises to 63% of its final voltage, it follows that the amplifier will, in any case, commence to operate at an earlier period than that indicated by the time constant value—even though it will not reach full gain until the voltage across C_2 approaches its final figure. In practice the values specified for R_2 and C_2 may require experimental modification, although they should cause satisfactory muting in most instances. If it is desired to change the muting period the value of C_2 should be altered, this being increased to increase the period and vice versa. Variations in muting period may also be achieved by varying R_2, but it must be remembered that too high a value here may prevent the screen-grid from obtaining an adequate final working voltage.

The connection to the screen-grid of the selected pentode in the amplifier requires a little further discussion. The existing h.t. feed to this electrode should be disconnected and a new resistor fitted between the electrode and the potential available from the muting circuit. The value of this resistor should then be such as to ensure that, when C_2 is fully charged, the screen-grid receives the same potential as it had previously. The screen-grid decoupling condenser on the amplifier chassis should, of course, be retained.

Can Anyone Help?

Requests for information are inserted in this section free of charge, subject to space being available

R.1155E Receiver.—J. Wakefield, of 26 Lancaster Road, Basingstoke, Hants, wishes to learn the value of each section of the tuning condenser, and would also like to purchase the Instruction Books for the Taylor Valve Tester type 47 and for the W/S No. 19 Mk. II.

* * *

Triplett Combination Tester model 1183.S/C.—J. M. Cammon, 5 Toronto Street, Ravenhill Road, Belfast, N. Ireland, would be grateful if anyone can lend, sell or help obtain a copy of the Instruction Manual. All letters answered.

* * *

C.R.T. CV.1397.—D. Featherstone, Alma House, Collingham, near Wetherby, Yorks, asks if any reader can give him the base connections and data of this tube, and whether or not it can be used in an oscilloscope.

* * *

V.H.F. Unit R-4/ARR2.—G. A. Douglas, 132 Derby Road, Widnes, Lancs, wishes to obtain the circuit or any other data applicable to this unit (also known as R.1585). Expenses will gladly be repaid.

* * *

Philips PCR.3 Receiver.—4173349 S.A.C. Tomlinson, 1103 M.C.U., R.A.F., Felixstowe, Suffolk, badly needs information on this receiver, and will gladly pay for any manual or service sheets available.

* * *

Soundmaster Tape Recorder Kit.—James D. Robinson, 5 Waver Green, Pudsey, Yorks, enquires if any reader can sell or lend him the construction manual for this kit which went off the market some years ago. Prompt return of original material loaned is promised, as photostat copies can be made. Expenses paid.

R.A.F. Valve Tester 4B.—L. B. Thomas, Ombersley, Murton Lane, Bishopston, Swansea, asks if anyone can supply details of the connections between testing and valve base portions of this instrument.

* * *

Loran Indicator APN4.—R. G. Collins, 64 Main Street, Cockermouth, Cumberland, wishes to buy (if reasonable) or to borrow a copy of the circuit and components list.

* * *

78 Receiver.—K. Armstrong, 11 Woodville Gardens, Ruislip, Middlesex, asks if anyone can give him information on the input voltage, plug connections and use of the Desyn trimmer. He already has the circuit.

W. Rogers, 231 Bridgnorth Road, Wollaston, Stourbridge, Worcs., also requires information on this receiver, and in his case needs the circuit. Any data paid for or returned at owner's request.

* * *

RF.26 Unit/R.3683 Receiver.—A. Speirs, 73 Brunswick Street, Edinburgh 7, wishes to obtain two metre modification data for the receiver and its circuit, and modification data for the RF unit, and would also be glad to hear from Edinburgh readers in particular.

* * *

Jan. '59 issue "Practical Wireless."—J. H. Fox, 95 Theobald Road, Coopers Lane Estate, Norwich, Norfolk, is anxious to obtain this number and will reimburse any expense incurred.

* * *

Philips 663.A.15 Televisor.—R. A. Clarke, 25 Tanners Way, Hunsdon, Ware, Herts, is anxious to obtain a service sheet for this set, and will gladly pay expenses.

In this month's episode, Smithy the Serviceman introduces his assistant, Dick, to the techniques involved in servicing high fidelity equipment

As soon as Dick entered the workshop one bright and sunny morning, Smithy the Serviceman realised, with the aid of just one passing glance, that his assistant had been visited once more by his Muse. Dick's excursions into doggerel occurred at fairly regular intervals, but they were still infrequent enough for Smithy to look forward to them. Smithy was prepared to accept the fact that Dick's verse was marked by a slight slackening of the rules of rhyme, and that there were occasions (even though the lines were delivered, with slightly off-beat accentuation, by the author himself) when scansion seemed entirely out of reach. Nevertheless, as Smithy remarked philosophically to himself, one could hardly expect Dick to be master of more than one trade. (It must be added that there were other times when Smithy, less philosophically, wondered if it wouldn't be mastery of poetry which Dick achieved first.)

As Dick hung his jacket by the door he looked expectantly at Smithy.

"It seems," remarked Smithy, answering the unspoken invitation, "that you have something to say to me. Is it another poem?"

"It is," replied Dick, proudly, "and I shall read it to you straight away. I call it '*The Audiophile's Answer*'.

"My super hi-fi
Demonstrates my reply
To a current and unjust prognosis,
'Cause I don't amplify
From a wish to comply
With an ostentation-neurosis.
Nor, with volume too high,
Do I foolishly try
To induce a deafened hypnosis;
For the records I buy
I just play quietlie
I don't want to keep up with the Joneses!"

"Umm," said Smithy, who had been listening critically. "If it weren't for the fact that you were trying to put over something approaching an acceptable idea, I would say that that was your corniest yet. You were scraping the barrel near the end, weren't you?"

"I was, rather," admitted Dick, completely unabashed at Smithy's remarks. "Anyway, what do you think of it?"

"I should send it in to the *Golden Treasury*," grinned Smithy, "enclosing a stamped self-addressed envelope."

Amplifier Servicing

Dick returned his opus to his pocket with a grimace.

"However," added Smithy, "I'm glad you've come in to work this morning all hi-fi minded, because I've got a hi-fi amplifier all ready for you to service."

"Oh, that's good," exclaimed Dick, forgetting all about his recent excursion into verse. "A hi-fi job will make a very nice change indeed. I'm getting a bit fed up these days with straightforward telly-bashing."

Smithy indicated the amplifier which required Dick's attention.

"I don't think you need take too long over it," he remarked. "From what I've heard of its performance, it just seems to be mildly non-linear. The first things you should test in it are the grid coupling condensers, after which you should check cathode voltages. If you haven't found anything by that time, you'll have to start trouble-shooting in real earnest."

"Hey, wait a minute," said Dick. "You're way ahead of me. What, for instance, do you mean by 'mildly non-linear'?"

"I mean that it's suffering from a case of non-linear distortion."

"I'm still lost! Surely distortion is distortion only, and can't be anything else. I don't get the adjective 'non-linear.' After all, I've never had any difficulty myself in recognising distortion in the past."

Smithy sighed.

"Since," he remarked, "your criterion for the ultimate in good music is that it should resemble Lord Rockingham's 'Hoots Mon,' I find it difficult to understand how you can even *claim* to recognise distortion. In any case, I have a feeling that you aren't entirely with me on the matter of high fidelity itself. Give me your definition of a hi-fi amplifier."

"A hi-fi amplifier," replied Dick promptly, "is an amplifier which makes music sound nicer than the sort of thing we used to hear on a.m. radios. Also, it should have a power output sufficiently high to enable it to handle occasional loud bursts of music without overloading."

"You aren't even half-way towards the right answer," Smithy commented. "The true function of a high fidelity equipment is to reproduce sound which is as near identical as is possible with the original. There is no question at all of reproducing sound which is 'nicer,' or 'louder,' or anything else whatsoever."

"But surely you can't really reproduce the original *sensations* experienced by someone who, say, heard the original sound in a concert hall. Or can you?"

"Not entirely," admitted Smithy. "With monaural—that is, single-channel—amplification you're tied to reproduction from one speaker, and the result obviously cannot be the same as is given by sitting in front of a widely spaced-out orchestra. Stereo systems help in getting over the single-point source of sound effect you get with monaural systems, and, if used wisely, can give you a strong impression that the sound source is more widely spread out.

"Anyway, I think we've gone into the true meaning of high fidelity far enough for now. As you know, the word 'hi-fi' is becoming a little overworked these days, and it is being tacked on to a large number of audio gears which vary over a wide range of performance and cost. I might add that I don't see anything too wrong with this state of affairs because, up to a point, the performance and reliability of hi-fi equipment increases as its cost increases; and one is able to obtain a rule of thumb measure of quality thereby. Mind you, there are some exceptions to the generalisation that the goodness of a hi-fi system varies directly with its price. For instance, there have been one or two very cleverly designed speaker and enclosure combinations which sound not too bad at all, despite the fact that they have relatively very low costs. Again, there are quite a few amplifiers on the market which have very good circuitry as well as high grade components, such as the output transformer, in the places which matter. However, their costs have been cut elsewhere by such devices as using electrolytics in place of paper condensers, running resistor wattage ratings a bit nearer the bone, and so on. Amplifiers of this type can give an excellent performance provided that a sharp eye is kept on the weaker features in their make-up."

"You said just now," Dick broke in, "that the true function of a hi-fi system is to provide an output which resembles the original sound as closely as it possibly can. I'm quite certain that there are a number of hi-fi system owners who don't look upon it that way at all."

"There are a few," agreed Smithy, "but I think you'll find, in this country at any rate, that most people who buy hi-fi outfits are real music-lovers, and that they know what the real thing sounds like. In any case, whatever the customer's viewpoint, the golden rule for servicing high-fidelity equipment is to make it reproduce sound correctly. Even if, when the owner gets his gear back after repair, he screws the top control hard back and indulges in purely 'woof and thump' listening!"

Distortion

"Right," said Dick briskly, "now let's get back to this distortion business. I'm beginning to get the impression that there are a lot more types of distortion than I ever thought existed."

"There are," confirmed Smithy. "But before getting on to them, let's quickly consider the basic definition of audio distortion. Which is that audio distortion exists whenever the output signal does not exactly resemble the input signal. And you couldn't have it simpler than that!

"Let's now start to look at the various classes of distortion. The first type to consider is *frequency* distortion. Frequency distortion occurs if all input frequencies within the band being handled are not given equal amplification by the system. With the tone controls set to zero, as it were, the response of a hi-fi amplifier should be flat over at least the minimum audible range of

40 to 15,000 c/s. In practice, a good amplifier will be reasonably flat over a much wider range, say some 20 to 30,000 c/s. The reason for this is not that the amplifier manufacturers are giving away something for nothing. It is just that, if the response is flat over this wider range, other types of distortion within the audible range are much less liable to occur."

"Does negative feedback help to ensure a flat response?"

"It helps very considerably indeed," said Smithy. "Speaking in very loose terms, you could say that n.f.b. has a sort of a.g.c. action. If an amplifier without n.f.b. had a response which was not flat, the n.f.b. circuit would feed back more energy at the frequencies which were given greater amplification."

"Thereby," interrupted Dick, "thumping down the peaks to the same level as the other frequencies."

Smithy looked rather cautious.

"Well, roughly speaking, yes," he agreed, at length, "though I must repeat that we are only talking in very general terms. I'm fairly certain that some of the more pedantic audio types would be after my blood straight away if I agreed wholeheartedly with your description of n.f.b. as a peak thumper-downer, but it's not too far off the ball. I had better add that, in a good amplifier, the n.f.b. brings the overall gain, on all frequencies, down to a markedly lower level than would be given to *any* frequency in the band without n.f.b.

"Right! Now the next type of distortion we want to consider is *non-linear* distortion. Non-linear distortion occurs when the input/output slope of the amplifier is not a straight line. If we plotted a graph for the input/output performance of a perfect amplifier we would get something like this. (Fig. 1.) You will see that the horizontal co-ordinate is input voltage, and that the vertical co-ordinate is output voltage. As input voltage increases, output voltage increases in exactly the same proportion, with the result that, by plotting all input voltages against all corresponding output voltages, you get a straight line, or 'linear,' characteristic.

"Non-linear amplification occurs if the input-output curve gets bent somewhere along its length. As it does here. (Fig. 2.) In this second sketch you will see that the straight line begins to bend when the input voltage rises above a certain, somewhat advanced, level. In an amplifier suffering from a characteristic of this nature you will hear non-linear distortion on sounds which are loud enough to enter the curved portion, whilst quieter sounds would be reproduced quite satisfactorily."

Overloading

"It looks to me," remarked Dick, "that your non-linear curve shows evidence of overloading somewhere."

"Overloading could, quite definitely, be *one* of the causes," said Smithy. "But you must remember that you will get non-linearity with *any* amplifier if you increase the input voltage above the level the amplifier is designed to handle. The limiting factor on input voltage being, of course, the output power the amplifier can deliver. As a result of this reasoning it is quite correct to assume that non-linearity on high inputs which were previously amplified correctly can point to a drop in the power handling capabilities of

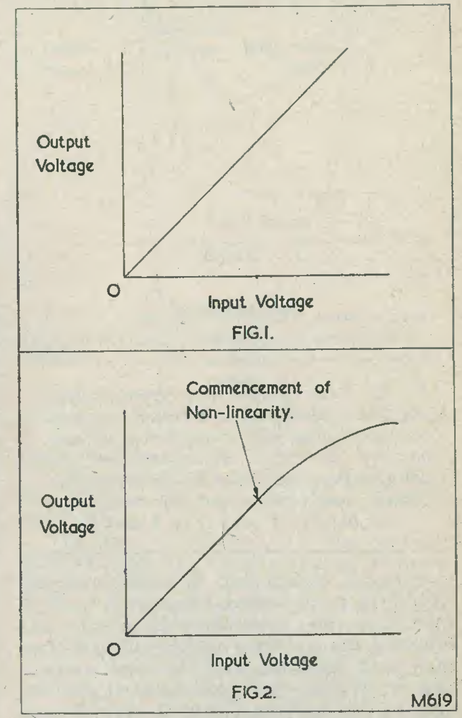


Fig. 1. If an amplifier is completely free from non-linear distortion, the graph given by plotting input voltage against output voltage will be a straight line. Fig. 2. The input/output characteristic of an amplifier which suffers from non-linearity on input voltages above a certain level

the amplifier; whereupon a sensible servicing procedure would consist of checking that the output bottles hadn't lost their initial youthful glow or that you didn't have something as silly as a low h.t. voltage. At the same time, what I said just now is also true: there are quite a few other faults which can similarly cause this type of non-linearity. A very likely probability is that a voltage amplifier valve[1] has shifted off the correct working point on its I_a V_g curve, and it can only handle low-level signals before it introduces distortion. For instance, here's another curve (Fig. 3). This is the I_a V_g curve of a voltage amplifier valve. When the valve

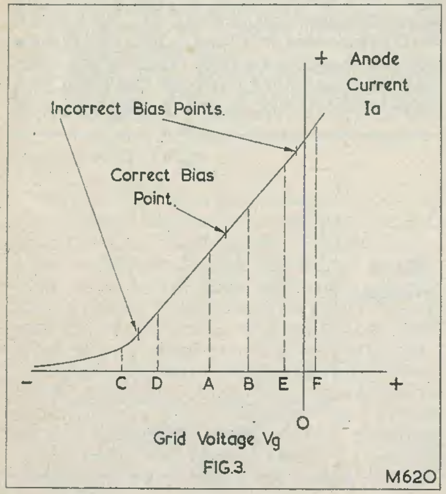


Fig. 3. An I_a V_g curve for a typical voltage amplifier. If the valve is biased correctly the input signal will be applied to a linear part of the curve, as occurs for grid voltages between A and B. Incorrect bias voltages could cause input grid voltages to lie between C and D or E and F

is correctly biased and it handles signals within the input voltage range of A to B, it introduces no noticeable distortion. If, however, the grid bias voltage shifts because of a fault condition then the input voltage may be applied to a partly curved section, such as that between C and D. In this case the valve will give reasonably linear amplification for low level signals, but will give non-linear amplification for high-level signals.

"In practice, the grid bias of voltage amplifiers under fault conditions usually goes positive instead of negative, as occurred just now with our C to D instance. Our input voltage may then be applied to points E and F of our curve. In this case the main cause of distortion will be due to a somewhat different effect. If the input signal causes the grid of the voltage amplifier to go sufficiently positive of the cathode for grid current to flow, then the anode of the preceding amplifier valve finds itself working into a much lower impedance than that represented by its anode load alone. So the preceding valve gives less amplification at volume levels which cause grid current and it is *that* which gives you most of your non-linear amplification."

"Phew," remarked Dick, "this is getting complicated. What happens if you haven't got a preceding valve?"

"Then you will have a device which has a similarly high internal impedance," replied Smithy, "such as a pick-up or a tape head, either of these with or without a step-up transformer according to type, or a radio tuner unit. All these gadgets can be represented by a generator in series with its own internal impedance (Fig. 4). If the grid-cathode impedance of the following valve drops as signal level increases, it follows that more voltage is dropped across the internal impedance, and we get non-linearity again."

"O.K.", said Dick. "By the way, why did you say that grid bias usually goes positive under fault conditions?"

"Because a fairly prevalent fault in a.f. amplifiers is that anode-to-grid coupling condensers go leaky," said Smithy, "and it needs only the slightest amount of leakiness in one of these components for grid bias conditions to go completely haywire. Let's assume that, in the typical circuit I've just sketched out (Fig. 5), the grid condenser develops a leak of, say, 50MΩ. Working with the voltages and values shown in the circuit you will find that this causes the following grid to receive a positive potential of very nearly 3 volts with respect to chassis when, previously, it was at zero potential. And 3 volts plus, on a voltage amplifier grid, is quite a lot."

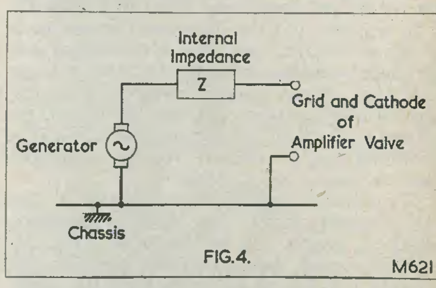


Fig. 4. A high impedance signal source, such as a pick-up, tape head, or radio tuner, may be represented as a generator in series with its own internal impedance

"So also," Dick broke in, "is 50MΩ leakage resistance in a condenser. How on earth can the average serviceman detect such a leakage? Even our Megger in the Workshop calls it a day above 20MΩ."

"That may be true," said Smithy, "although I must point out that you can get Meggers which read very much higher than 20MΩ, and that it just happens that our particular model is a 20MΩ type. So far as leaky grid coupling condensers are concerned, you don't need to measure leakage directly in any case. There's a dodge I told you about some time ago which seems to be worth repeating again. To check for leaky condensers you first of all switch on the amplifier and turn its volume up to full. Then, one after the other, you temporarily short-circuit the grid leaks of each valve. Since grid leaks are almost invariably returned to chassis, this test can usually be done with a screwdriver or, say, a test lead having one end clipped to chassis. When short-circuiting each grid leak, connection to the chassis end *must* be reliably made before you connect to the grid. We now come to the important part of the check. When you short-circuit each grid leak you should hear nothing at all from the loudspeaker apart, perhaps, from a cessation of background hiss. If, on the other hand, you hear a *crackle*, then you will know that the appropriate grid

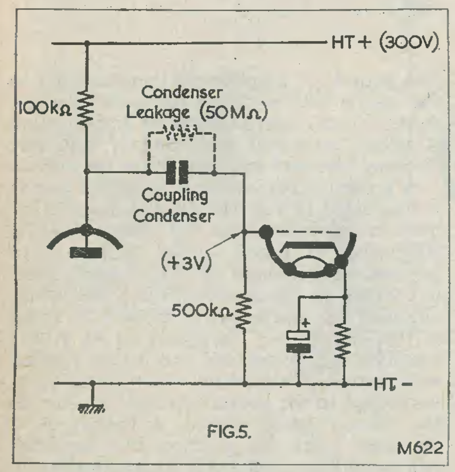


Fig. 5. An a.f. amplifying circuit with typical component values. If the coupling condenser were to develop a leakage resistance of 50MΩ, the potential on the grid of the second valve would rise by very nearly 3 volts

was not at the same potential as the earthy end of its leak before you applied the short-circuit; and you should at once suspect the appropriate grid coupling condenser for leakage. Not forgetting, of course, that other snags, such as an open-circuit grid leak, or a fault in the valve itself, could also cause the trouble."

"Well, that's a neat dodge," commented Dick.

"It has quite a few advantages," admitted Smithy, "one of the most important being that it is very quick to carry out."

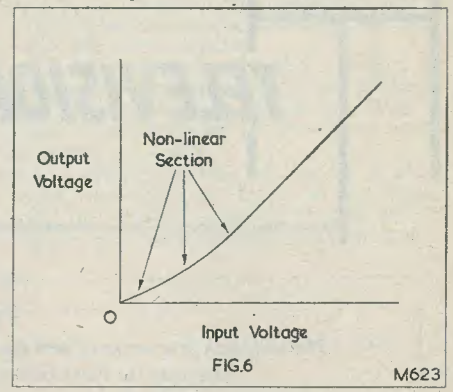


Fig. 6. Another amplifier input/output characteristic. Unlike Fig. 2, non-linearity occurs in this instance at low level signals

Incorrect Operation

"Can non-linearity take up any form other than that shown in the curve you sketched out?"

"Oh, yes," said Smithy. "In fact you can have well-nigh any shape you like! Here's a possible non-linear input/output curve (Fig. 6). In this case the amplifier will sound badly distorted on low level signals but not too bad on high level signals. When you get this sort of thing, it's a good plan to have a look at the output stage first. Quite a few hi-fi amplifiers these days tend to be a little Class AB-ish, and in the presence of a fault condition, might wander over towards Class C[2]. This would give you distortion of the type we're considering. So output bias and output bottle performance need to be closely looked into. Don't forget, though, that this fault could also be caused by non-linearity elsewhere in the amplifier."

Smithy stopped talking and looked at his watch.

continued on page 748

1 As opposed to a "power" output valve.

2 Class AB operation indicates a bias condition wherein the grids of a push-pull output stage are more negative than occurs under normal, Class A, conditions. Class C describes the case wherein the grids are biased beyond cut-off.

THEORY

UNDERSTANDING TELEVISION

PART 16

By **W. G. MORLEY**

The sixteenth in a series of articles which, starting from first principles, describes the basic theory and practice of television

Owing to illness, it was not possible for the sixteenth article in this series to appear in last month's issue of *The Radio Constructor*. In consequence, we now carry on from the contribution which appeared in the March issue.

In the March article we discussed the vision i.f. amplifier of the television receiver, and illustrated how the individual responses of the tuned circuits employed could be combined together to form an overall response suitable for amplification of the vision i.f. signal. We also dealt with sound and adjacent channel rejectors, showing some typical circuits and networks. This month we proceed to an examination of the sound i.f. strip, the sound detector, and the video detector.

The Sound I.F. Amplifier

The sound i.f. amplifier of the television receiver normally takes up a simple form which should be readily familiar to those who have had experience with conventional a.m. sound radio circuits. As we saw in Fig. 80 (*a*)[1] it is normal practice to have a common i.f. amplifier stage immediately after the tuner unit, this stage having a relatively flat frequency response and being capable of amplifying both vision and sound i.f. signals. The sound i.f. amplifier is then coupled to the anode circuit of the common amplifier valve. Since a useful degree of amplification is already provided the sound i.f. amplifier in many receivers employs one valve only.

A typical single valve i.f. amplifier circuit is illustrated in Fig. 90. In this diagram we have a pentode valve, to whose grid is connected a tuned circuit adjusted to resonate at the sound i.f. This tuned circuit is coupled to the anode of the common i.f. amplifier and draws energy from that circuit at the sound i.f.[2] The signal on its grid is amplified by the pentode and is then applied to a second tuned circuit which, in its turn, is coupled to the sound detector. In Fig. 90 the second tuned circuit is shown as a bandpass pair. (In practice, this bandpass pair would have relatively loose coupling in order to ensure that bandwidth response was kept to the minimum commensurate with adequate transfer of signal energy. A probable degree of coupling would be that which was just sufficiently tight to enable the bandpass effect to appear.)

Despite the gain provided by the common i.f. amplifier, a number of receivers employ two valves, instead of one, in the sound i.f. strip so that the requisite degree of sensitivity may be achieved. In such amplifiers the two valves will be coupled together, via sharply tuned circuits, in normal manner. Also met occasionally are receivers which dispense with the common i.f. stage altogether, vision and sound i.f. strips being coupled directly to the anode circuit of the tuner unit mixer valve. In this case the sound i.f. strip would almost inevitably employ two valves.

The frequency response requirement of a television sound i.f. amplifier is, largely, that sufficient selectivity be provided to ensure that picture information from the vision i.f. does not reach the sound detector, whence it would, in consequence, be passed on to the sound amplifier. When sound i.f. selectivity is inadequate, the most troublesome result is, usually, the reproduction of audible "frame buzz" from the loudspeaker. Frame buzz makes itself evident as a harsh tone whose basic frequency is the frame frequency of the television system.

Owing to the high intermediate frequency employed for the sound i.f. (in British receivers 38.15 Mc/s) there is no necessity to guard against attenuation of higher audio frequency sidebands due to excessive selectivity. The higher audio frequencies, around 10 kc/s or so, cause sidebands to appear which are removed from the carrier by only some 0.025% of the frequency of the latter, and the relatively simple tuned circuits which appear in sound i.f. amplifiers do not discriminate against frequencies as close to the carrier as this.

The Sound Detector

The next part of the television receiver to consider is the sound detector. Whilst this does not differ to any marked extent from the sound detectors employed in a.m. receivers it is worthwhile devoting a little time to its operation due to the fact that it affords a useful introduction to the functioning of the vision detector.

The sound detector illustrated in Fig. 90 is typical of the circuits employed in television receivers. Although a germanium diode is shown in the diagram, a valve diode would function just as well.

The detector section of Fig. 90 is illustrated, on its own, in Fig. 91 (*a*) and, again, with the chassis connection removed, in Fig. 91 (*b*). Apart from this lack of chassis connection, Fig. 91 (*b*) is identical to Fig. 91 (*a*), and this second diagram clearly illustrates the fact that the diode, the tuned circuit across which the modulated r.f. appears, and the load resistor (with its parallel condenser) are all in series.

In Fig. 92 (*a*) we see a typical a.m. sound i.f. signal. If this modulated signal were to appear across the tuned coil of Fig. 91 (*b*), the diode would function as a rectifier, with

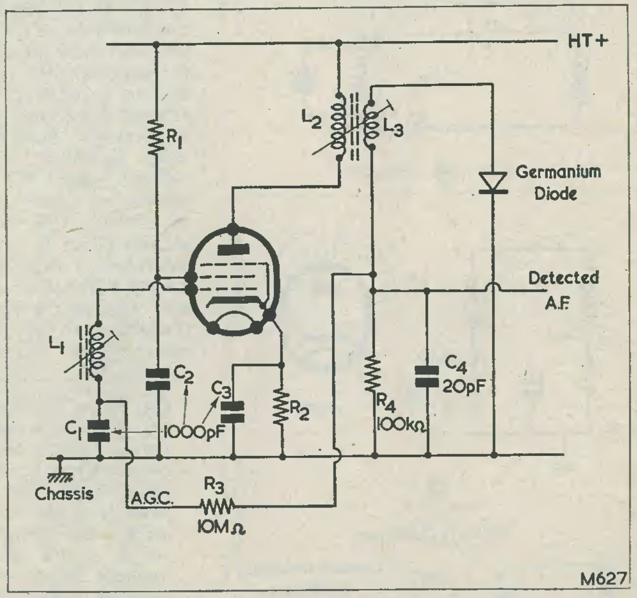
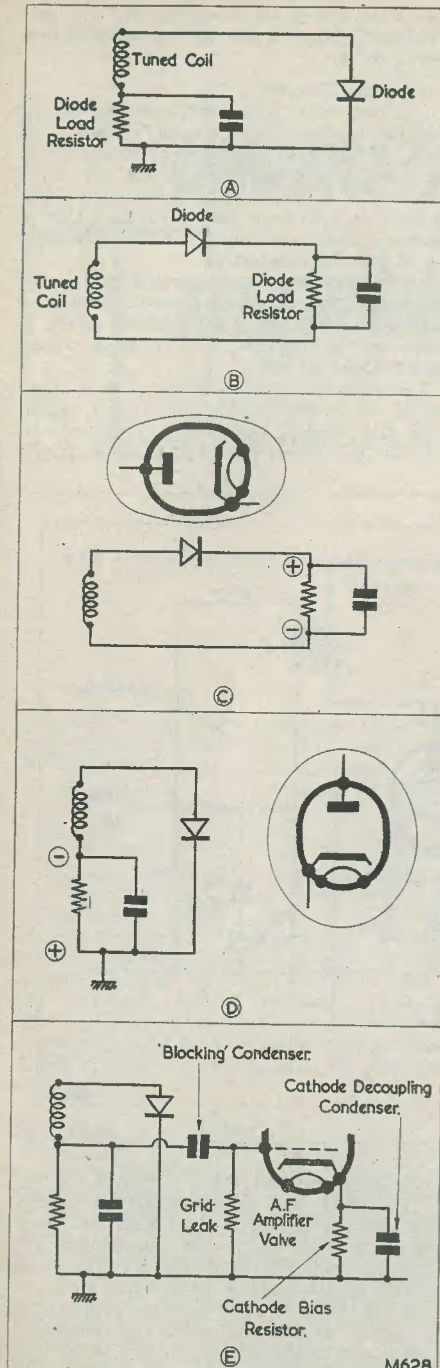


Fig. 90. A typical single valve sound i.f. amplifier

[1] Understanding Television, part 14, February 1959 issue.

[2] Because of this, the first sound i.f. coil may also be made to function as a sound rejector, if desired.



the result that only half the radio frequency signal would appear across the load resistor. Also, due to the presence of the condenser in parallel with the load resistor, the voltage appearing across the resistor would not drop to zero between peaks of rectified r.f. voltage. The resultant effect is shown in Fig. 92 (*b*), wherein it may be seen that the condenser discharges slowly into the load resistor between peaks of rectified r.f. voltage.

As a result of the detector circuit, we obtain across the load resistor the a.f. signal shown in Fig. 92 (*c*), this being a replica of that which originally modulated the r.f. signal. This audio signal can now be applied to the audio amplifier of the receiver.

The condenser in parallel with the load resistor of Fig. 91 (*b*) performs several important functions. Its presence is necessary, in the first place, in order to provide a path for the flow of r.f. current in the detector circuit. Secondly, it ensures that only a small proportion of the applied r.f. appears in the detected signal which is passed to the audio amplifier. The value of the condenser cannot, however, be made too high or it will cause attenuation of the higher audio frequencies and may even cause distortion due to inability to discharge into the load resistor sufficiently quickly between peaks of r.f. voltage. Both these effects are of somewhat academic interest in the present context, where the relatively high sound i.f. allows low value condensers to be employed in parallel with the load resistor; but the second effect is worth a little further consideration if only because it offers an illustrative parallel of a similar difficulty which may arise in the video detector. Fig. 92 (*d*) illustrates the sort of distortion which would result if the condenser did not discharge

Fig. 91 (a) The detector section of Fig. 90. (b) When the chassis connection is removed and the circuit slightly re-drawn, the rectifying action of the diode becomes clearly apparent. (c) Illustrating the polarity of the d.c. component across the diode load resistor. The valve diode shown in the inset alongside the germanium diode would give a similar polarity. (d) The polarity of the d.c. voltage across the diode load resistor when the chassis connection is re-introduced. If the diode were reversed, the polarity of the voltage across the load resistor would reverse also. (e) Due to the presence of a d.c. component across the diode load resistor it is necessary to feed the following i.f. amplifier grid via a blocking condenser, in order to prevent bias conditions being altered. (In practical circuits a low-pass filter would also be inserted between the diode load resistor and the grid)

sufficiently quickly into the load. In this diagram the modulating level is dropping more rapidly than the condenser can discharge, and distortion results.

We have just remarked that the presence of the condenser in parallel with the load ensures that only a small proportion of the i.f. signal is applied to the subsequent audio amplifier. Despite this, it is usually necessary to further reduce this small proportion if nstability is not to occur. As a result many television receivers employ low-pass filters[3] after the detector, the circuits used in these being similar to the examples shown in Figs. 93 (*a*) and (*b*). Fig. 93 (*a*) shows a filter employing a resistor and condenser, whilst the filter of Fig. 93 (*b*) uses a choke and condenser. Occasionally, two filters, one following the other, are employed. These filters are inserted between the diode load resistor and the grid of the first a.f. amplifier valve.

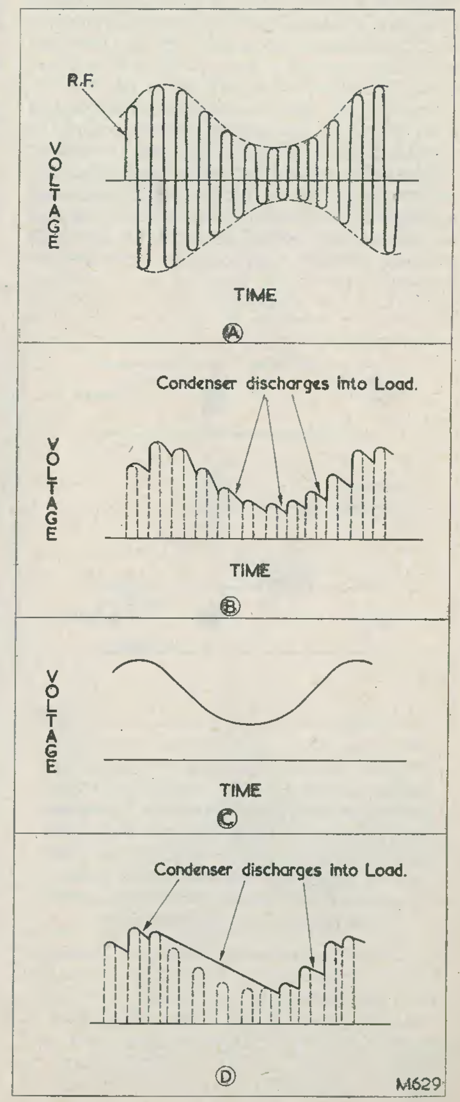
Returning to our basic detector circuit of Fig. 91 (*b*) we should now consider another important factor. This is that the detected signal across the diode load resistor consists, in fact, of a d.c. voltage varying at audio frequency. Fig. 91 (*c*) indicates the polarity of this voltage, and Fig. 91 (*d*) re-introduces the chassis connection of Fig. 91 (*a*) whilst still retaining the polarity indications. It should be noted that if the detector of Fig. 91 were reversed the polarity of the voltage across the load resistor would reverse also.

Due to the fact that a d.c. voltage appears across the detector load resistor, it follows that we cannot connect this component directly to the grid of the following a.f. amplifier or we would upset the bias conditions under which that valve works. In consequence, we have to insert a blocking condenser in series, as is shown in Fig. 91 (*e*). This condenser allows the passage of a.f., and enables the grid of the valve to remain biased via its own grid leak.

[3] A filter which impedes high frequencies but which allows the passage of low frequencies.

Fig. 92 (a) Illustrating the make-up of an amplitude modulated r.f. signal. The dotted line (the "modulation envelope") shows the nature of the modulating signal. For clarity it is assumed that the r.f. signal has a much lower frequency than would normally be employed. (b) The detected signal appearing across the diode load is indicated here by the full line. The dotted line indicates the half-cycles of r.f. which would appear across the load resistor if the parallel condenser had no effect. (c) The a.f. voltage which results from detecting the signal of (a). (d) If the parallel condenser discharges into its load too slowly, downward-going modulation may suffer the distortion shown here

If we wish to do so we may take advantage of the voltage on the load resistor by using this to provide automatic gain control. In this event it is essential to connect the detector such that the free end of the resistor is negative (as occurs in Fig. 91). This negative voltage may be applied to a suitable low-pass filter, to remove the a.f., whereupon we obtain a d.c. voltage which increases as signal amplitude increases. In Fig. 90 an a.g.c. circuit of this type is employed, the a.g.c. voltage being applied to the grid of the amplifying valve via the coil in its grid



3A

circuit, and the low-pass filter being provided by R_3 and C_1.

In a number of television receivers the simple a.g.c. circuit of Fig. 90 is not employed. Instead, an additional diode is used for a.g.c. purposes, this being fed either by the tuned circuit which also feeds the signal detector or by the previous anode. The main advantage of employing a separate a.g.c. diode is that this enables a delaying action to be obtained. A delayed a.g.c. circuit is illustrated in Fig. 94. In this diagram the presence of the delay voltage ensures that the diode does not rectify until the input signal reaches a level equivalent to the delay voltage. In consequence, no a.g.c. voltage becomes available and no a.g.c. action takes place until a signal which is sufficiently powerful to overcome the delay is received. In practical circuits the a.g.c. delay voltage may be provided with the aid of a potential divider connected between chassis and the h.t. positive line. A suitable source for the delay potential, and one which would be economical of components, would be available from the positive voltage appearing in cathode bias circuits.

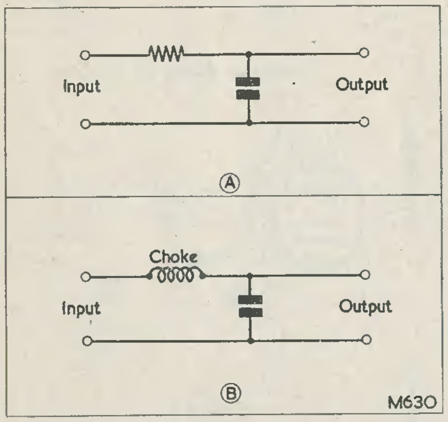


Fig. 93. Two typical low-pass filters. The values chosen for the resistor and condenser, or choke and condenser determine the frequencies which are attenuated. In some circuits the input capacity of a valve may be relied upon to provide the capacitive part of the filter, whereupon a physical condenser is not then required

The Video Detector

The function of the video detector is to rectify the video i.f. signal passed to it, and thereby enable the modulating signal to become available for the video amplifier. In carrying out this function the video detector operates in exactly the same manner as does the sound detector. However, it differs from the sound detector in a number of respects, these being entirely due to the nature of the signal the video detector handles.

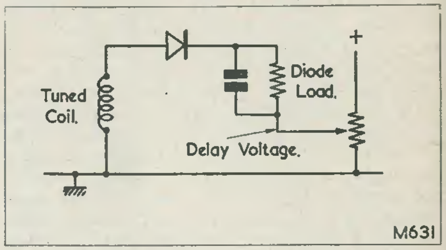


Fig. 94. A delayed diode detector circuit. The diode does not rectify until the peak r.f. voltage across the tuned coil exceeds the delay voltage

A typical video detector circuit is shown in Fig. 95. It will be seen that this is identical with that of Fig. 91 (*a*) with the exception that the chassis connection into the series combination of coil, rectifier and load resistor now appears at the junction of the load resistor and rectifier instead of at the junction of the load resistor and the coil.

The vision i.f. signal differs from the sound i.f. signal insofar that the highest modulating frequency is of the order of 3 Mc/s, whereas the highest sound modulating frequency is of the order of 10 kc/s. A particularly important point is that, due to the necessary presence of a condenser across the detector load resistor, the impedance presented by these two components in combination becomes lower as the detected video frequency increases. When this impedance decreases a greater proportion of the detected signal is dropped across the internal forward resistance[4] of the detector itself, and the higher video frequency voltages developed across the load may tend to become attenuated in consequence.

We have already seen that the audio detector distorts downward-going modulation if the condenser in parallel with the load resistor does not discharge sufficiently quickly into the load resistor between r.f. peak voltages. With video detector circuits the risk of distortion from this cause becomes much more acute, as in this case the condenser must discharge into the load resistor sufficiently quickly to enable downward-going modulation at 3 Mc/s to be accurately followed. The extreme case in the British television system occurs when picture information drops from white level (100% modulation) to blanking level (30% modulation). In a system having a limiting frequency

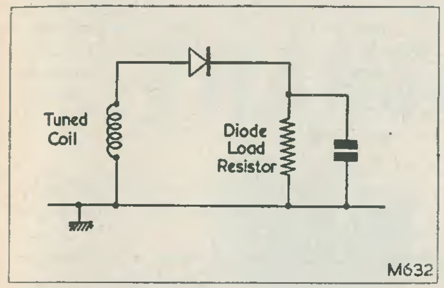


Fig. 95. A video detector circuit

of 3 Mc/s the time taken for this drop in signal amplitude to occur should be that occupied by one half-cycle at 3 Mc/s, i.e. one-sixth of a microsecond. The condenser across the detector load should be capable of discharging into its load, from full to 30% detected voltage, in less than one-sixth of a microsecond, if distortion on downward-going video modulation is not to occur.

To overcome both the effects just mentioned it is necessary for the parallel condenser *and* the load resistor to have low values. These low values will, firstly, reduce the effect of lowered load impedance at high video frequencies and, secondly, will ensure that a quick rate of condenser discharge on downward-going modulation takes place.

In practical video circuits it is normal to find diode load resistors having values of 4 to 5kΩ, and parallel condensers having values of 5 to 10pF. As may be imagined, the use of a load resistor having as low a value as 4 to 5kΩ results in reduced detection efficiency. Also, a tight coupling to the anode of the last i.f. amplifier is necessary if i.f. energy is not to be lost. It should further be pointed out that the stray capacities to chassis appearing across the load resistor are quite liable to be of the order of several picafarads even before the physical condenser is connected up to it; with the consequence that the condenser has a value which may be only two to three times greater than the unavoidable stray capacities which are already present.

The necessity for keeping the stray capacity across the video load resistor to a minimum provides the reason for making the chassis connection to the series combination of tuned coil, diode and load resistor at the junction of the coil and the resistor, rather than at the junction of the rectifier and resistor, as occurred in Fig. 91 (*a*). Since the tuned winding in the video detector circuit has to be very tightly coupled to the last i.f. amplifier, as we have just observed, it is usual to employ coupling circuits such as that shown in Fig. 96, wherein two tuned coils are interwound. Arrangements of this type result in the secondary coil having a high stray capacity to the h.t. positive line, and thence to chassis. If such a secondary coil were employed in a circuit similar to that of Fig. 91 (*a*), this high stray capacity would be effectively connected across the detector load resistor.

Choice of Diode

In present-day television receivers it is almost universal practice to employ a germanium diode, rather than a valve diode, in the video detector stage. The reasons for this choice are as follows: the germanium diode is more convenient to install, it requires no heater voltage, it can be made to have a lower forward resistance than that given by a conventional valve, and it can have

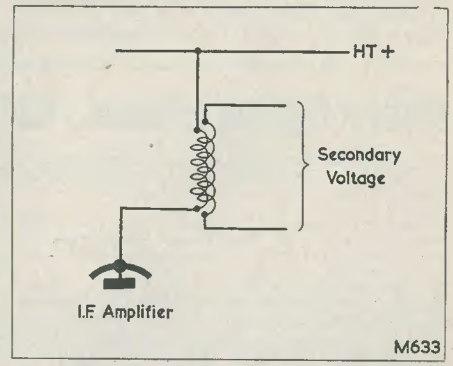


Fig. 96. In order to obtain sufficiently tight coupling to the video detector, arrangements of the type shown here, wherein primary and secondary tuned coils are interwound, may be employed. Such arrangements are liable to result in the secondary winding having a high stray capacity to chassis

a lower internal self-capacity and capacity to chassis.[5] A minor disadvantage with the germanium diode (and, especially, with the low forward resistance types which are used as video detectors) is that it has a lower peak

[4] The resistance offered by the diode when conducting.

[5] In a valve diode this last capacity would, unless special precautions were taken, be largely provided by the capacity between cathode and heater.

inverse voltage[6] than the valve equivalent. Some care has to be taken in receiver design, therefore, to ensure that the video detector cannot, under very strong signal conditions, be subjected to an excessive i.f. voltage.

It is common practice to screen the video detector components of a television receiver. The reason for this is that the function of detecting signals which change very rapidly in amplitude (as do normal television signals) results in the generation of harmonics of the intermediate frequency. Such harmonics could cause overall instability in the receiver if they were picked up by earlier stages.

Finally, it is necessary to deal with the polarity of the detected video signal which appears across the load resistor. As we shall see in a later article, the design of the video amplifier, the method of connection to the c.r.t. and the transmission system employed, all affect the choice of preferred polarity. In consequence, the polarity of the detected signal may be either positive or negative, and the diode of Fig. 95 may be connected either way round to suit. Unlike the sound detector, the video detector does not provide an a.g.c. voltage; so the requirements for polarity pertaining to a sound detector which is also an a.g.c. detector do not apply here.

Next Month

In next month's article we shall discuss i.f. amplifiers suitable for systems employing an f.m. sound carrier.

[6] The peak inverse voltage is the highest voltage having reverse (i.e. non-conducting) polarity which may be safely applied to a rectifier before the latter breaks down.

In Your Workshop *continued from page 741*

"My goodness," he exclaimed with a start, "I've been nattering away for nearly an hour, and we haven't even started work today."

"Not to worry, Smithy," laughed Dick, turning to his bench, "I'll soon make up for it! But, seriously speaking, there must be quite a bit more you could tell me about hi-fi amplifiers."

"There is, indeed," agreed the Serviceman. "All I've dealt with up to now has been frequency distortion, together with a very general look at non-linear distortion. We'll have to carry on with the subject when we have our next 'gen session' together."

Electrical Engineers Exhibition, 1959

A record number of home and overseas visitors attended this year's Electrical Engineers Exhibition which took place at Earls Court from 17th to 21st March.

The total attendance for the five days was 68,249—an increase on the 1958 figure. There were 639 overseas visitors from 71 countries against 600 visitors from 60 countries last year.

Exhibitors report excellent business and a number of important enquiries including one for ¼ million pounds' worth of equipment. One firm received an order for an £18,000 night security system. Three enquiries were received for giant clocks such as the 60ft diameter show-piece which dominated the Exhibition. An American source has also asked for details of the clock. The price of such a clock is £11,500.

The firm who made the clock (Synchronome Ltd.) also completed the sale of a carillon (electronic chimes) at the Show. It will be installed in O'Connel Street at the premises of one of the largest jewellers in Dublin. The chimes—equal to 10 tons of bells—will be heard over a 2-mile radius in the centre of the city.

Many store executives visited the special display of shop-window lighting on the first floor, and each of the 40 performances of AURAMA—the new electronically controlled indoor entertainment—was played to packed houses. A total of 7,200 people saw Aurama during the five days.

Among important visitors to the Show were The Rt. Hon. Hugh Molson, M.P., Minister of Works, Mr. Charles Forte the famous caterer, and trade delegations from France, Russia, China and many other countries.

The Exhibition was also seen by television viewers on both Channels in addition to broadcast reports at home and overseas.

Next year's Show will take place from 5th to 9th April at Earls Court.

Martindale to Retail New Voltage Tester

The new Martindale fixed prod voltage tester manufactured by the electrical equipment division of Martindale Electric Co. Ltd., of Westmorland Road, London, N.W.9, will be marketed through retailers as well as being available from the company and its distributing agents.

This means that the new voltage tester which is already in heavy demand in industry will be stocked by electrical, ironmongery and hardware stores, etc.

Martindale have produced a special counter display unit for retailers into which one of the testers can be fitted. The slogan is "Better safe than sorry!"

The fixed prod voltage tester will interest maintenance electricians, linesmen and "do-it-yourself" enthusiasts. The new tool incorporates one of the prods actually in the body of the tester, making it easier and more convenient to use for many purposes.

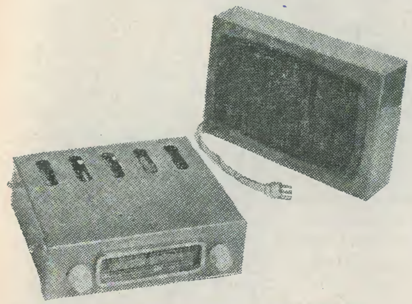
The user can tell immediately whether a line is alive and the voltage (up to 600V). The tester also shows whether it is a.c. or d.c. and which is "earth." It is particularly useful in places where there are mixed voltages.

The prods are unique. They have spring-loaded sheaths which normally cover the points and which are pushed back when the prods are held against the surface being tested. The search lead prod can be held back slightly by means of a bayonet action.

The search prod holds a high rupturing capacity fuse of half ampere in series with a current-limiting resistance of 68 ohms. This combination will provide absolute protection even if a complete short should occur.

The new Martindale fixed prod voltage tester costs £2 17s. 9d.

The "MAYKIT" TRANSISTORISED CAR RADIO



Part 3

by Richard Myers

This series describes fully a modern car radio design which may be built by any motorist—with or without experience of radio work—from the receipt of the components to the testing of the unit. Suggestions for car installation are included. The printed circuit and condensers are by T.C.C.

Step No. 24: The Output Stage

Packet No. 5 should now be opened and the following components identified: one ⅜in rubber grommet; two ¼in rubber grommets; two right-angled metal brackets; ten 4BA screws and nuts; C_{21}, 250μF; one 4-pin plug complete with outer metal shell; one 4BA solder tag and one metal condenser holding-clip. Also required for this stage are the speaker, the output stage chassis, the transformer marked GB.1707, a length of white p.v.c. screened lead and the output transistor.

Fit the ⅜in rubber grommet, this being the larger grommet, into the ⅜in hole as shown in Fig. 7. Fix in position one of the smaller grommets just alongside one of the transformer mounting holes. Secure the earth tag as shown.

Mount in position the two right-angled metal brackets, as shown in Fig. 7, with the smaller sides being held to the chassis by means of the 4BA screws and nuts—but do not tighten as yet. Next, similarly fix the transformer into position on the brackets—it does not matter which way round the transformer is positioned; i.e. the positioning of the leads is not important. Now tighten all the holding screws of the metal angle brackets.

Next, clamp the condenser C_{21} into position by means of the metal holding clip in such a manner that the *red* end is nearest to the transistor position. (See Fig. 7.)

We must now fit the output transistor. Before commencing this, however, take a look at Fig. 8 and note the correct manner in which to carry this out.

Fix the transistor through from the underside of the chassis; i.e. the body of the transistor should be on the same side as that eventually to be occupied by the speaker frame and cone (see Fig. 7). Assemble as shown in Fig. 8, except for the red sleeving over the two smaller protrusions which we will fit later. Before finally tightening the transistor into position, ensure that neither of these two smaller protrusions from the transistor are in any way contacting the metal edges of the apertures.

later. Remove the green cord material. Bare the ends of the black and red wires to a length sufficient to pass through the plugs on the paxolin material and to protrude through the open plug ends. Push these wires through the plugs—see Fig. 9 for the correct

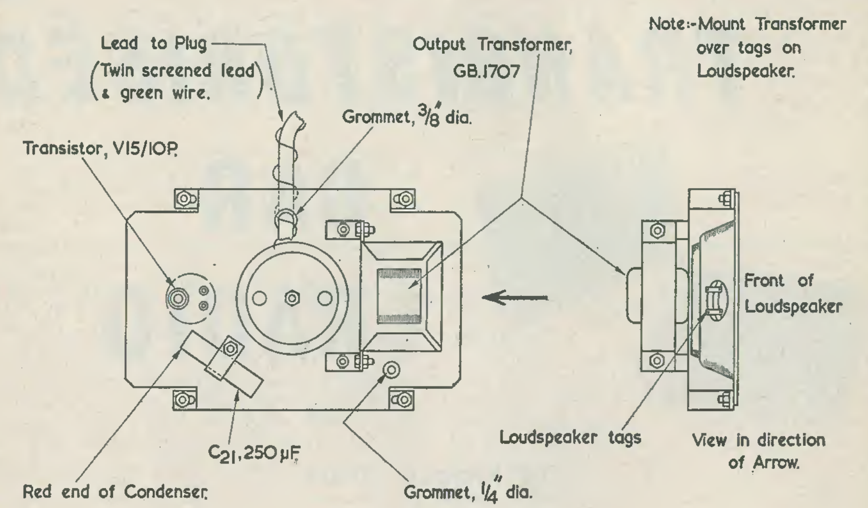


FIG.7
Loudspeaker Chassis Assembly.

M624

Step No. 25

Putting aside the output stage chassis for the time being, we must next deal with the connecting links between the valved portion of the receiver and the transistor stage.

Before cutting the white p.v.c. cable, however, the motorist should decide the final position of the speaker/transistor assembly within the car. There are many alternatives with respect to the foregoing, and later the reader will find that we have described one method of speaker enclosure and mounting. The car owner may decide to install the speaker system within a glove compartment; or, providing there is sufficient room, behind the control panel, etc. Upon this decision will depend the length of cable required in individual circumstances.

To proceed, cut the cable to the required length—a little extra length in addition may be helpful at a later time should a re-siting of the speaker be desired. Slip over the cable the metal shell; see Fig. 9. Cut and remove the white p.v.c. covering with a razor blade, about an inch from the end of the cable, push back the metal braiding and form a length of this sufficient to solder to one of the plugs connections—bend them over and solder securely into position. Remove the surplus wire with the aid of a pair of cutters. Dealing with the metal braiding next, this should not be passed through the plug as it is much easier to solder this material to the paxolin end of the metal connection. Having completed this, take the green p.v.c. wire and solder to the plug in the same manner as the red and black wires. Fit the metal shell over the paxolin mounted plugs as shown in Fig. 9, bending over the small metal lugs so that the whole assembly is rigidly held together. It should be noted here, however, that with the connections just made care should be taken to ensure that no bare wire is visible within the metal shell except for the metal braiding; in other words, that no short circuits are possible.

At a short distance from the metal shell, securely tie the green wire around the white cable so that a firm anchorage is made. For those who remember their Boy Scout days, a clove-hitch is ideal for this purpose. Follow this by twisting the green wire around the white cable and secure at the far end by means of a further knot, leaving sufficient

green wire for soldering to the speaker/transistor chassis as described in the next Step. Finally, cut and remove the surplus green wire.

Step No. 26

We now have to solder into circuit the connecting wires, as described above, and the various components on the speaker/transistor chassis—but before so doing, the actual speaker itself should now be fitted into position.

Refer back for a moment to Fig. 7. This shows the correct manner of securing the speaker to the metal chassis. Note that the rear of the speaker protrudes through the large circular cut-out of the chassis, and the speaker is so positioned that the two solder tags are situated nearest the output transformer. Now, temporarily secure the speaker by means of two 4BA screws and nuts only, one each in opposing corners. (This last instruction applies only to those who are constructing the speaker enclosure described later. If you are mounting the speaker into the car, either behind the facia or control panels, as it is now assembled and when wired, all four corners of the speaker should be secured to the chassis.)

Returning to Fig. 9, connect into circuit the output transformer by soldering the *red* wire to the black end of the condenser C_{21}; the *orange* wire to the *red* end of C_{21}; the *green* wire to the earth solder tag, and the black wire to one of the speaker tags. (*NOTE:* The black wire should be taken through the small rubber grommet before soldering. It is immaterial which speaker tag is connected to the black wire, the nearest physically will suffice.) The remaining speaker tag should now be connected to the earth solder tag, the wire being fed through the same rubber grommet as for the other speaker connection.

Before dealing with the transistor connections, a few words of advice to the motorist who has not previously had any experience of these components would probably not come amiss.

Note: A Warning

Transistors may be damaged by excessive heat, especially that conducted from a soldering iron when it is placed on the connecting pins of the component for an unduly long period. It is essential, therefore, that two golden rules be observed when soldering the transistor into circuit. Firstly, only apply the iron for the shortest time necessary to make the required joint and for the solder to flow freely—a "dry" joint here would probably result in no audio output! Secondly, form a heat shunt by holding—between the iron and the transistor—and on the transistor protrusion itself—a pair of pliers. In this manner as little heat as possible, consistent with a good soldered connection, is applied and the heat shunt will dissipate most of the conducted heat away from the transistor. Provided these two simple rules are observed, no damage will result to the transistor, although it should be mentioned here that this is of very rugged construction and more robust than the usual type of small transistor commonly to be seen in portable radios.

To continue, bare both ends of a short length of red p.v.c. wire and solder one end to the *red* end of C_{21}. Cut two small lengths of the red sleeving supplied, just sufficient to ensure that the base and emitter connections of the transistor are effectively insulated from the chassis, and place these into position over the above-mentioned connections—leaving them sufficiently exposed so that a soldered joint may be made. Solder the other end of the wire coming from C_{21} to the emitter connection of the transistor—and do not forget the warning above!

We must now connect into circuit the cable which we have previously fitted with the plug. Push the cable, together with the attendant green wire, through the large rubber grommet on the chassis.

Cut the white p.v.c. and remove as before; pull back the metal braiding and form a connection to this for soldering purposes; remove the green cording material, and bare the ends of the red, black, and green wires.

Firstly, solder the metal braiding to the earth tag (see Fig. 9), the green wire to the collector (bend this up slightly) of the transistor; the black wire to the *black* end of C_{21}, and the red wire to the base of the transistor.

The output stage is now complete, and the motorist would be well advised to check his completed unit together with the instructions above, the drawings and the illustrations.

The metal speaker enclosure, illustrated herewith, is described later, but not all motorists will desire to add this. Where this is not required, the constructor, after testing the receiver in the manner about to be described, should fit the speaker according to his own specific requirements. For this purpose, a further set of holes are contained on the output chassis adjacent to the speaker holding screws. When securing the output stage to the car, take care to ensure that the speaker cone is not damaged in any way.

Step No. 27: Testing and Aligning

Preliminary to testing and aligning the receiver, the car owner will require an aerial. Such fittings are many and varied, it being left to the motorist to decide which type is preferred. That used with the prototype is of the chromium-plated, three-section, pull-out variety. When purchased, they are completely fitted with a length of coaxial cable connected at one end with an input plug and at the other with two separate connections. Of the latter, one terminates in a metal ring or tag, this being connected to the clear p.v.c. wire. It is this connection which is secured to the actual aerial itself. The remaining connection is that for earthing to the car chassis at a suitable point adjacent to the aerial.

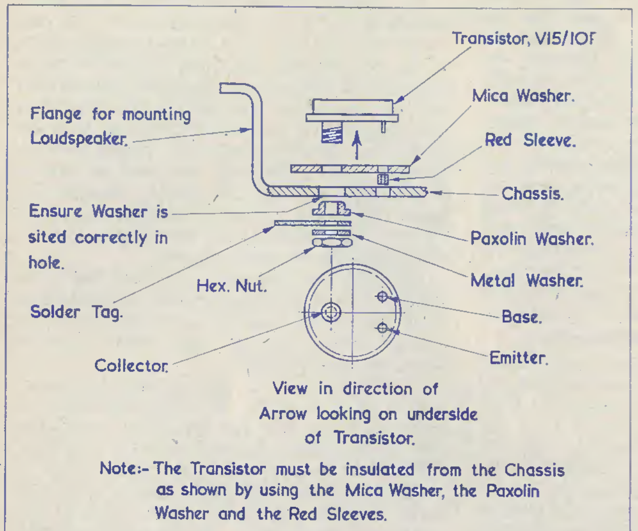


FIG. 8.
Method of assembling Transistor.

The fitting of these aerials is simple and virtually self-explanatory—the obvious golden rule being that the aerial must be insulated from the car metalwork. Any garage will fit an aerial for a small charge where the motorist does not feel capable of undertaking the task himself.

It is possible, of course, for the motorist to test the receiver in the car by temporarily using a short length of wire as the aerial for the time being.

Ideally, if one is energetic enough, the receiver could be tested on the bench—provided, of course, one is prepared to remove the battery from the car. If a spare and fully-charged battery is available (few of us are this lucky!) then this would be ideal for testing purposes.

Before taking the radio to the car, temporarily connect a red p.v.c. covered wire to the receiver chassis. This is best done by securing one end to the 6BA screw situated near to the aerial input socket. When the radio has been tested, this connection should be removed—it serves only as a battery positive connection during the testing period. In normal use, of course, the fitting of the radio to the car metalwork automatically provides this connection, the positive (+) side of the battery being connected directly to the car metalwork via the heavy metal braiding.

Connect, temporarily, to the battery minus (−) terminal the *black* fused lead from the receiver. To the battery positive (+) terminal connect the *red* wire from the receiver. Plug in the aerial, where this has been fitted, or failing this, connect temporarily a length of wire, acting as an aerial outside the car, to the aerial input socket. This aerial connection should, of course, be pushed down so that it makes good contact with the tag to which the small choke is connected. Plug in the output stage.

All the foregoing may be carried out with the radio resting on the static portion of the car bonnet—in which case do not forget the use of an old blanket or newspaper—scratches on the cellulose can be rather annoying! Alternatively, providing the two battery connections are lengthened, operations may be commenced on the seating; again do not forget the old blanket material, seating leather or p.v.c. covering is expensive!

Switch the radio on by rotating the volume control and allow a few moments for the radio to warm up. If working correctly, this will be known by the "hissing" noise from the speaker when the volume control is turned to the position of maximum gain.

Tune in to a *weak* station by rotating the tuning unit control shaft. Next, adjust the i.f. transformer cores, of which there are two in each transformer, one being reached from the top and the other from the bottom of each metal can enclosing the transformer, in the following manner.

Dealing with the first i.f. transformer first, this being that situated between the second and third valves (valve No. 5 is the tall one), insert a *thin*-bladed screwdriver through the aperture at the end of the receiver chassis and very slowly rotate the first iron dust core

which is situated inside the metal can of the transformer. Note that the core slot is only some $\frac{1}{32}$in wide. At some point found aurally, the station will be at its loudest. When this position has been found, withdraw the screwdriver and insert under the same i.f. transformer, where an aperture is provided under the printed circuit board.

despatch and therefore only a slight amoun of rotation of the i.f. cores, in the direction which produces the desired results, is required. For the technical radio enthusiast, the i.f. is 480 kc/s.

Having obtained the loudest possible signal from the station, repeat the process in order to achieve the maximum possible

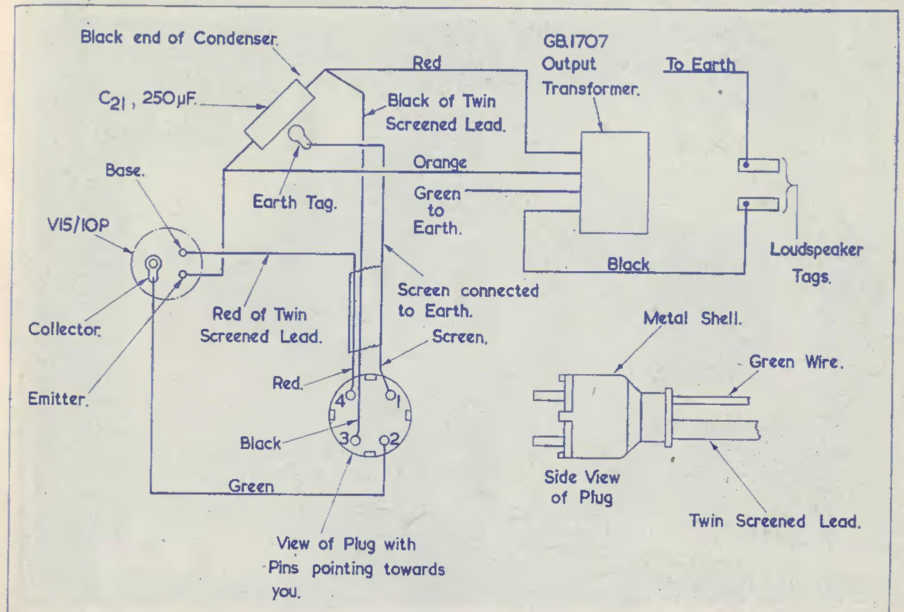


FIG. 9.
Wiring Diagram of Loudspeaker Chassis Assembly.

Repeat the trimming process until the station is at its loudest.

NOTE: The tuning unit will have to be slightly moved in order to gain access to this latter core. There should be no difficulty with this as the tuning unit is only held temporarily in position by one screw and nut. The screwdriver used for this operation *must* be a small and thin watchmakers' type in order to fit the slotted head of the transformer core. The incorrect use of a larger type screwdriver will damage the dust iron core very easily. The correct type of screwdriver is that commonly used by watch repairers and this may be obtained from the manufacturer of the car radio kit.

Repeat the same trimming process with the second i.f. transformer, slowly rotating each core until the best aural results are obtained.

The i.f. transformers have already been pre-aligned by the manufacturer before

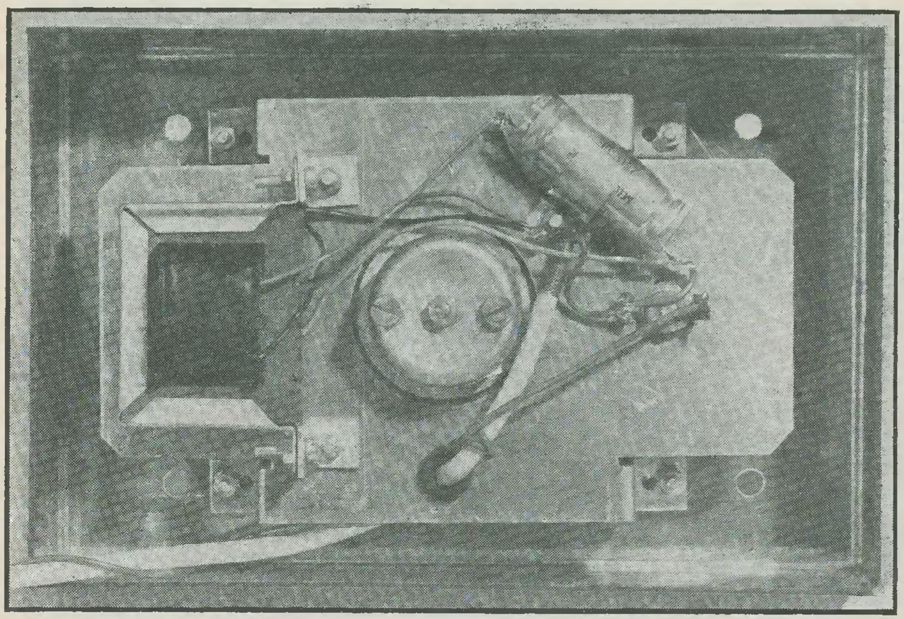
signal. Switch off the receiver by rotating the volume control anti-clockwise until a click is heard.

Step No. 28

Next, take the white panel and screw on by means of the four small self-tapping screws, to the receiver chassis front so that the white side is facing outwards. It is advisable here to first drive the screws home and then remove them before mounting the panel. In this manner, the screws cut their own thread in the somewhat smaller fitting holes, and, in any event, it does save a slipping screwdriver from marking the white panel which eventually is to become the dia backing. The cut-out at the top of the front panel should fit *under* the red station pointer, and this part may have to be slightly "sprung" in order to fit the panel into position and over the two control shafts.

Now fit the station marked dial and front panel temporarily into position in front of the red pointer and ensure that this pointer is not fouling either the dial or the white front panel as it traverses from one side to the other. Secure the tuner unit to the chassis by means of the remaining three 6BA screws and nuts.

Change to the Long wave position by pulling *out* the tuning control, and adjust the pointer to the Light Programme, on the lower red scale, by rotating the tuning control. In a similar manner as described above, slowly adjust C_{12} until the station is received and at its loudest, *without adjusting the tuning control*. Follow this by tuning in



Showing the rear of the speaker/output stage assembly. Vacant holes are for a forced fit insertion of a plastic speaker grille

Step No. 29

Switch on the radio, allow a few moments for warming up and, while this is happening, fix the two small white knobs.

Adjust the pointer so that it is indicating the Light Programme position on the Medium waves. This is shown on the upper black scale just numerically below the 250 marking. Push the tuning control *in* for the Medium wave band position. Adjust the volume control so that the station is heard and slowly rotate, with the aid of the screwdriver, the middle trimming condenser C_{13} (see Fig. 4). Make the adjustment gradually and slowly until the Light Programme is received at the maximum possible volume *WITHOUT ADJUSTING THE TUNING CONTROL*. With this completed, tune to a weak station *with the tuning control*, and then slowly adjust C_6 (see Fig. 4) for maximum volume.

to a weak station and adjust C_3 and C_8 for maximum volume.

The reason why a weak station is used for final adjustments, is that this receiver incorporates a very efficient system of a.v.c. (automatic volume control). If a strong station was used, there would be no apparent change in audio level when adjusting the various trimmer condensers as described above.

The receiver is now correctly aligned.

Step No. 30

Remove the leads from the battery and remove the red lead from the temporary connection on the filter box chassis. Remove the two control knobs and the aerial and speaker connections. Secure finally into position the receiver front and the printed dial by means of the two screws provided, and replace the knobs. Make sure that the tuning control knob is so fitted to the shaft that the wavechange mechanism will function satisfactorily.

Fit the receiver to the grey hammered metal case, ensuring that the valve ventilation apertures are uppermost, and secure firstly by the 6BA screw just adjacent to the aerial input socket. Finally, clamp the chassis into position by the four large screws, taking care that each is so adjusted that the pressure is even over-all.

Either fit the radio to the car yourself, or get your local garage to carry out the necessary work. If you are fitting yourself, several methods are possible, and will suggest themselves according to the type and make of car, and the final position that the radio will eventually occupy.

One method would be to obtain two strips of aluminium, about 5½in long x 6in wide, allowing for ventilation, bend along the length midway and drill to fit the receiver holding bolts and the car metalwork. A further method of achieving the same object would be to use aluminium strip, secured to the receiver bolts and passed right around the outer casing.

The receiver chassis must, of course, be securely connected to the car metalwork in order to obtain the required 12 volts positive potential. Removal of a little celluose in order to obtain a good bonding with the receiver metalwork is advised here. DO NOT rely on the aerial metal braiding for this connection.

The necessary minus potential may be easily obtained from the "live" side of the lighting switch usually mounted on the control facia or dashboard, thus obviating a long lead to the car battery.

Making the Speaker Cabinet

The speaker cabinet shown in the illustrations herewith consists simply of an aluminium chassis 8¼in x 5¼in x 2in., this size allowing of more than sufficient room in which to mount the output stage as shown. The chassis employed by the individual motorist does not, of course, have to conform to the above stated dimensions. Provided the output stage will comfortably fit within, and the chassis will suit the size requirements of the car, any reasonable size may be purchased.

It should be mentioned here, however, that a matching speaker may be obtained from the car radio component supplier as an optional extra. In many types of car, such a cabinet will be unnecessary, all that is required being simply the output stage as shown in Fig. 6.

The speaker grille shown was one that happened to be to hand, but suitable alternatives would be either cloth speaker material or expanded metal mesh. These latter alternatives would, however, have to be fitted within the metal chassis between the speaker and the inside of the chassis.

The apertures cut in the chassis deck were made with two types of valveholder cutters, and as these will not be available to the average motorist, and it being unlikely that the purchse of these would be economic, we suggest that a series of holes be drilled, in a geometrical pattern pleasing to the individual. For this, the chassis deck should be measured and marked with a pencil according to the pattern decided, the points to be drilled then centre-punched and drilled with, say, a ⅛in high-speed drill.

For those who own, or have access to, an I.O. (International Octal) and a B9A type valveholder cutter, the illustration will provide all the information that is required. The larger apertures are made centrally and spaced equidistantly on the chassis deck with the four smaller B9A holes being made around in the pattern as shown. A drawn outline of the 7in x 4in speaker made on the chassis deck will considerably assist in the positioning of the smaller apertures.

The four outer and somewhat smaller holes were made for fitting to the chassis the speaker fret referred to above. After drilling has been completed and the output stage mounted within the chassis, the outer face should then be given a coat of paint or cellulose—colour to individual choice!

Interference Suppression

The two major causes of interference are the dynamo and the ignition system; some motorists may also have trouble with the windscreen-wiper motor (if electrically driven and not vacuum operated), the petrol pump or even the heater motor.

Dealing with the sparking plugs first, cut-lead suppressors fitted into each lead, not forgetting the distributor suppressor, are obtainable at most garages for a modest sum. Fitting instructions are supplied or the garage will fit them while you wait for a small additional fee.

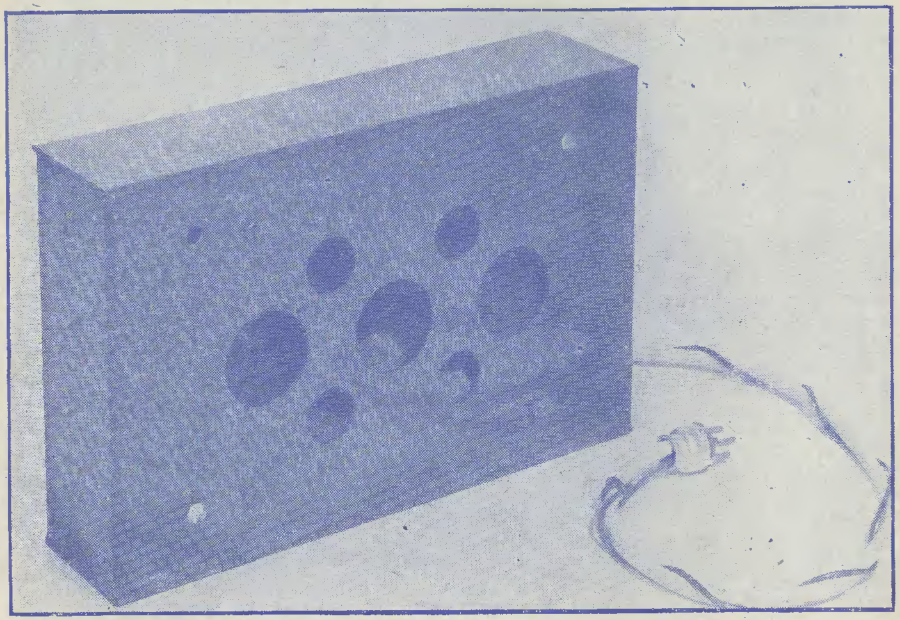
It is most important to bond the engine to the chassis of the car. Modern engine units are rubber bonded to the chassis and this does not help in the radio sense. Obtain some stout copper braid and secure this to a convenient bolt on the engine itself and the other end to a further convenient bolt on the chassis—do not forget to allow sufficient slack to "take-up" the engine rock or movement when running.

Suppressor condensers should be obtained and fitted to the dynamo and ignition coil. If troubled by the electric pump, windscreen motor or the heater motor, similar condensers will also have to be fitted. These may be obtained from your garage or most radio component dealers. They should be condensers valued at 1µF, with a low voltage rating, the purpose of which is to by-pass the surge currents—which cause the interference—to the metal body or chassis of the car.

When dealing with the dynamo, connect one end of the suppressor condenser to the live insulated terminal—ensuring that it is the denser from the terminal marked "CB" to the metal chassis, ensuring that a good bonding is obtained.

Similarly deal with the windscreen wiper motor, the petrol pump and the heater motor should you be troubled by them, by connecting a condenser from the "live" side of these motors to the chassis of the car.

Since the car radio description in this series has been completed, a dial lamp and



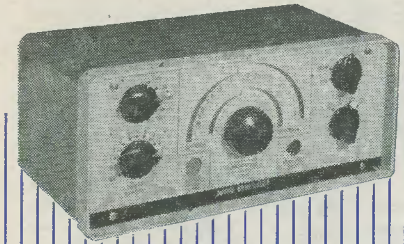
The speaker case, containing the output stage, consists simply of a blank chassis punched with three I.O. holes and four B7G holes—using the appropriate value aperture punches

one connected to the brush and *not* to the field. The brush terminal is always the larger and heavier terminal and is usually labelled "B" or "D." Make doubly sure this is so, and if in doubt, brush away any adhering matter. One terminal will be labelled "F"; do NOT connect to this terminal under any circumstances. Secure the body, if a proper suppressor condenser, or the second connection, if not, to the nearest bolt which is making contact with the main chassis or engine. Do not overlook the fact that any paint or oil, etc., that may act as insulation at the connection points must be scraped away in order to obtain a secure bond. Keep all condenser leads as short as possible and, in any case, do not extend them by adding additional leads.

To deal with the ignition coil, fix a con- assembly has been included with the kit. The bulb and holder will be found in Packet No. 3.

Fitting instructions for this are as follows: Before securing in position the white front panel, scrape away a little of the white paint at the bottom of the left-hand side. Take the bulb holder and twist the tags so that they do not protrude beyond the width of the bracket of the holder. The tag which is attached to the threaded part should be soldered to the bracket. To the other tag, solder the length of black p.v.c. wire.

Solder the holder to the panel so that the bracket fits between the panel and the engraved dial. Take the other end of the black wire through the hole in the panel and solder it to the tag on the *back* of the volume control to which the *red* wire is connected.



The JASON AG10 AUDIO GENERATOR

by G. Blundell

SPECIFICATION.—Variable Capacity Tuned Wien Bridge.
Frequency Range.—Sine Wave 10*c/s*–100 *kc/s; Square Wave* 10*c/s*–50*kc/s.*
Distortion.—Less than 1%.
*Square Wave.—Rise time—*2*µsec.; Mark/space ratio—adjustable.*
Accuracy.—Within 3% *of scale reading.*
Output.—Co-axial socket. Switched attenuator giving 0.1*mV*, 1*mV*, 10*mV*, 100*mV*, 1*V*; *Multiplier,* 0–10 *times; Impedance,* 600Ω at 0.1*mV*–1*V*; 6,000Ω *at* 1–10*V.*
*Valves.—ECF*80 (2), *EF*80 (1), *EZ*80 (1).
*Power Requirements.—*200–250*V* a.c., 28*V.A. Separate transformer available for* 100–150*V a.c.*
*Dimensions.—*11½*in x* 5⅜*in x* 7*in.*
*Weight.—*9*lb.*

To anyone interested in amplifiers, pre-amplifiers and audio frequency equipment in general, an audio frequency generator is a necessity. The generator described in this article covers a wide range of frequencies, has both sine and square wave output, and is equipped with an accurate attenuator. The circuit is, however, quite simple and inexpensive components have been used without loss of performance.

Circuit Description

The Jason AG10 consists of a Wien bridge oscillator with V_1 and the pentode section V_2 for amplifying and phase reversing. The triode section of V_2 is used as a cathode follower output stage, while V_3 is the squaring stage.

The essential parts of the Wien bridge oscillator are shown in Fig. 2. Two arms of the bridge C_1 R_1 and C_2 R_2 form a potential divider giving an output at point *b*. This potential is in phase with the input potential at point *a* at a frequency given by $f=\frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}}$. For convenience R_1 is made equal to R_2 and $C_1=C_2$ and at frequency f the voltage is attenuated by 9½dB due to R_1 C_1 and R_2 C_2. Continuous oscillation at this frequency will therefore result if the output at point *b* is fed back to the input point *a* through an amplifier with negligible phase shift and a gain or amplification of 9½dB.

As a single amplifying stage gives a phase reversal of 180°, i.e. the input and output are in opposite phase, two amplifying stages are required to obtain zero phase shift.

However, if there was too much positive feedback, overloading of the amplifiers would occur and therefore some method of stabilising the gain of the amplifier section at the low value of 9½dB (approx. three times) is required. This is achieved by negative feedback to the cathode of V_1 through the opposite arms of the bridge formed by the Thermistor TH and R_{11}. The Thermistor is a device which alters its resistance according to the current through it. It is, in fact, the temperature of the Thermistor which alters according to the current and it is the temperature change which causes the resistive change. The actual Thermistor element may be seen inside the

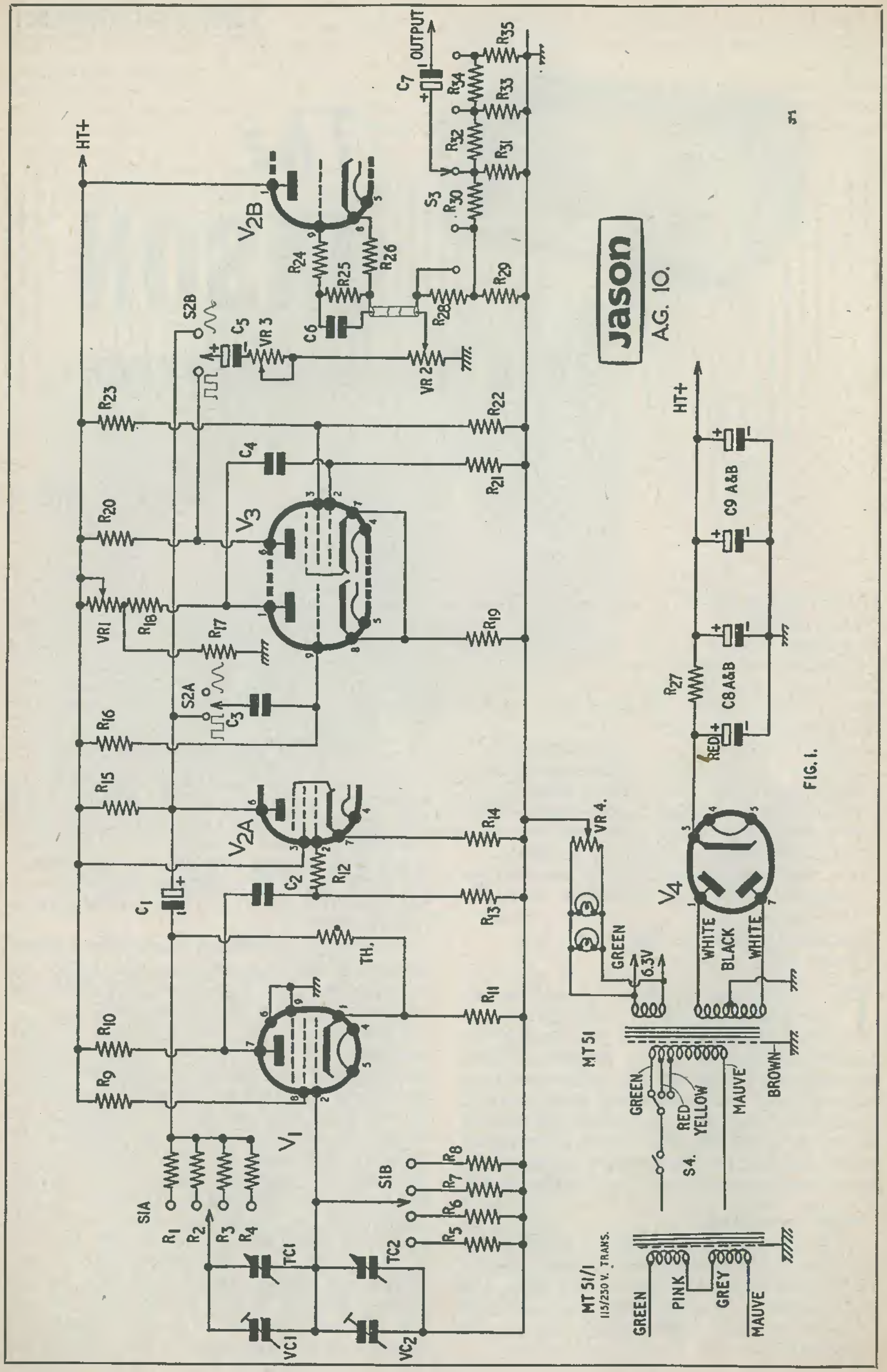


FIG. 1.

glass capsule as a small bead supported by two wires, the size of the bead being smaller than 1/50 of an inch diameter.

The Thermistor therefore changes the feedback to the cathode according to the current through it and therefore stabilises the output voltage. This stabilisation is very effective, the output variation being less than 1dB over the whole range.

Comparing Fig. 2 with the circuit diagram Fig. 1, C_1 and C_2 correspond with the variable condenser VC_1 and VC_2 and R_1 R_2 to the switched resistors R_1-R_4 and R_5-R_8 respectively.

In many designs the frequency is varied by altering the resistance. As usual, there are a number of factors influencing the choice of the method which is used. The greatest difficulty with the variable capacity method is that high resistances are involved on the low frequency range and the oscillator becomes very susceptible to hum pick-up. Very thorough screening is required to prevent this difficulty. However, the advantage of the capacity method is that a more accurate scale can be achieved. Condenser manufacturers are used to producing condensers for ordinary radio sets very cheaply to an accuracy of 2%. A ganged variable resistance to the same accuracy would cost ten or twenty times as much and there is, therefore, considerable incentive to use the variable condenser.

Cathode Follower Output Stage

There are a number of considerations in the design of this stage which are not immediately apparent. One of the main attributes of the cathode follower stage is its low output impedance, but no advantage is taken of this in the present unit except on the 10 volt range. Another useful feature is the high input resistance, and it will be seen that use is made of this point.

JASON AG10 AUDIO GENERATOR

COMPONENTS LIST

Specially set out for easy reference to Fig. 1

Resistors

R_1	30MΩ 5% h.s.
R_2	3MΩ 1% h.s.
R_3	300kΩ 1% h.s.
R_4	30kΩ 1% h.s.
R_5	30kΩ 1% h.s.
R_6	300kΩ 1% h.s.
R_7	3MΩ 1% h.s.
R_8	30MΩ 5% h.s.
R_9	470Ω
R_{10}	22kΩ ¾W
R_{11}	3.3kΩ
R_{12}	1kΩ
R_{13}	470kΩ
R_{14}	270Ω
R_{15}	10kΩ
R_{16}	10MΩ
R_{17}	100kΩ
R_{18}	10kΩ
R_{19}	4.7kΩ
R_{20}	15kΩ 5% h.s.
R_{21}	2.2MΩ
R_{22}	22kΩ
R_{23}	47kΩ ¾W
R_{24}	1kΩ
R_{25}	470kΩ
R_{26}	470Ω
R_{27}	2kΩ 3W
R_{28}	5.4kΩ 1% h.s.
R_{29}	666Ω 1% h.s.
R_{30}	5.4kΩ 1% h.s.
R_{31}	666Ω 1% h.s.
R_{32}	5.4kΩ 1% h.s.
R_{33}	666Ω 1% h.s.
R_{34}	5.4kΩ 1% h.s.
R_{35}	666Ω 1% h.s.

Resistors are ½W 20% carbon unless otherwise specified.

Condensers

C_1	8μF 350V wkg. electrolytic
C_2	0.05μF 300V wkg.
C_3	0.22μF 300V wkg.
C_4	0.22μF 300V wkg.
C_5	16μF 350V wkg. electrolytic
C_6	0.05μF 300V wkg.
C_7	50μF 150V wkg. electrolytic
C_{8A+B}	32+32μF 350V wkg.
C_{9A+B}	50+50μF 275V wkg.

Valves

V_1	EF80
V_{2A+B}	ECF80
V_{3A+B}	ECF80
V_4	EZ80

Miscellaneous

VR_1	100k preset
VR_2	50k with switch S_4
VR_3	100k preset
VR_4	300Ω preset
TC_1	Trimmer 0–20pF
TC_2	Trimmer 0–20pF
Twin	500pF gang
TH	Thermistor
S_1	2-pole 4-way ceramic
S_2	2-pole 2-way
S_3	1-pole 5-way

Mains Trans. MT51

Chassis, case, bakelite panel, insulated shaft.—Jason

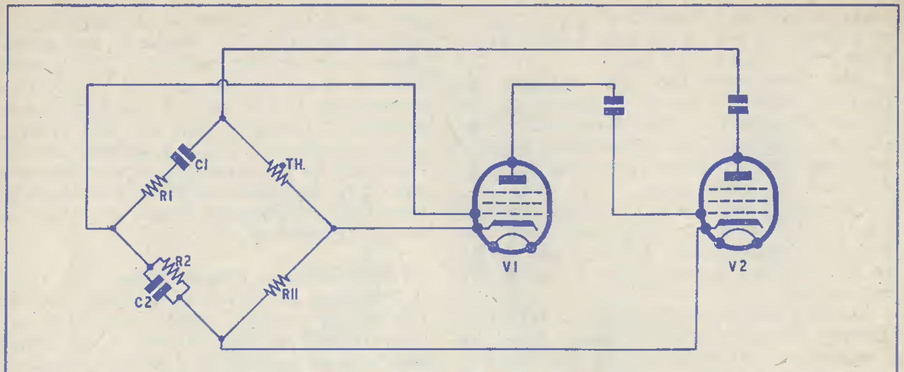
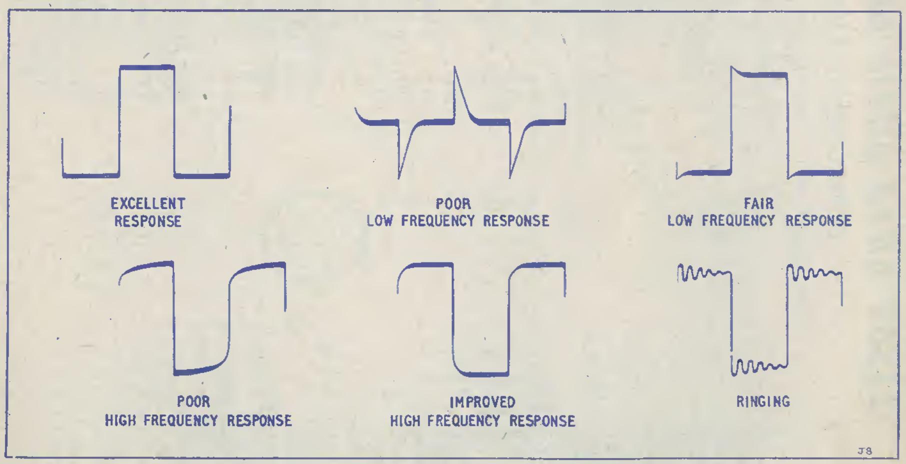


FIG. 2.

The reasons for the design of the various parts of this stage will now be discussed. The network R_{28}–R_{35} is the main attenuator giving an attenuation $\frac{1}{10000}$ or 100 microvolts output signal in the minimum position. If this had been positioned before the cathode follower then it would have been impossible to decouple the h.t. line sufficiently to prevent the output waveform being very poor. The decoupling condensers are already large (C_{8B}, C_{9A} & B) but there is still a very tiny signal left from the oscillator on the h.t. line, especially at the low frequencies, which would have been fed through the cathode follower stage to the output. Therefore the main attenuator must follow the output stage and no advantage can be taken of the low output impedance. This stage is therefore operating only as a power output stage, and the attenuator could have been connected in the anode circuit. However, the working voltage of C_7 would have to be much greater



Typical waveforms from an amplifier under test, showing the effect on a square wave input of variations in the frequency response. Judicious use of both sine and square wave testing is essential for evaluating amplifier performance.

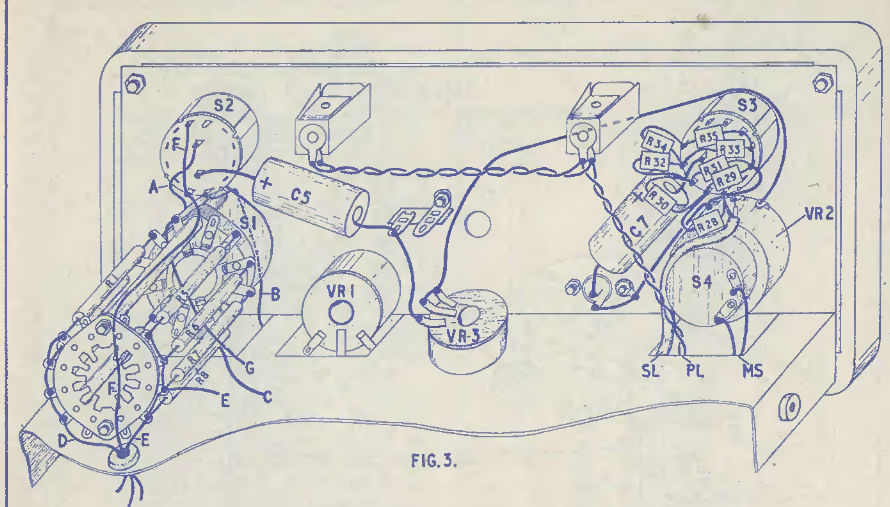


FIG.3.

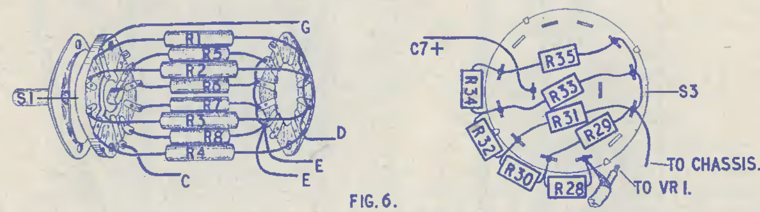
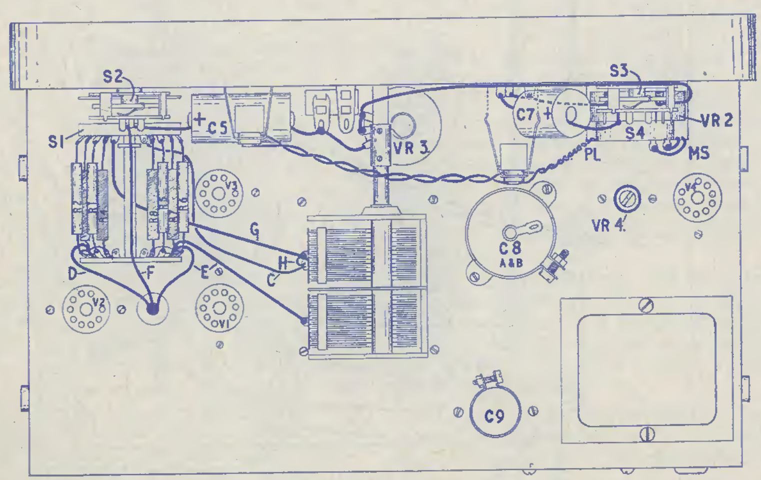


FIG. 6.



A.G.10.

FIG.4.

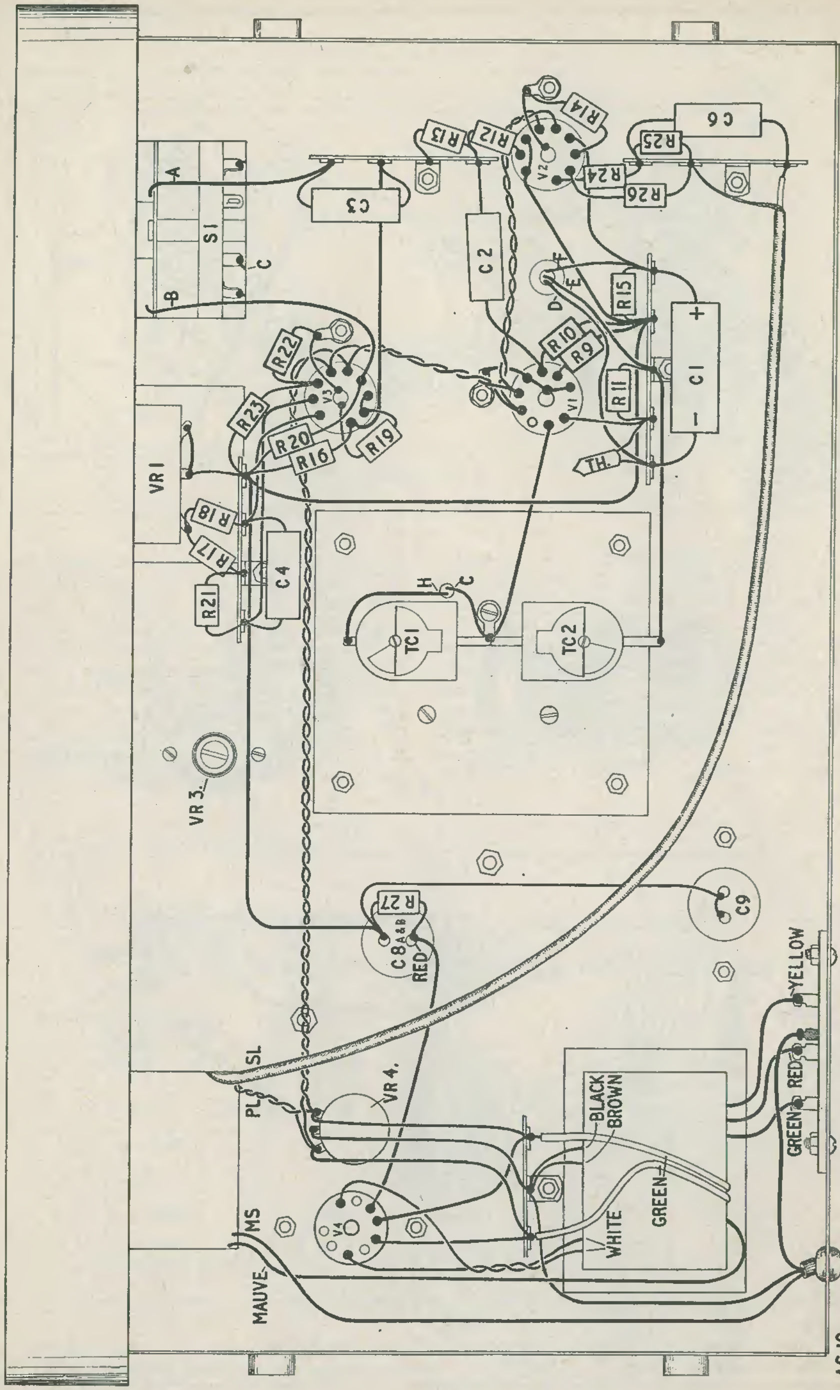


FIG. 5.

AG.10.

and, more important, the advantage of the high input impedance would have been lost.

A simple explanation of the high input impedance of the cathode follower will now be given and from this it will be seen that the value of C_6 can be relatively small and yet a good low frequency response can be achieved. It will also be seen that the effect of the capacity of the screened cable is removed from the circuit so that VR_2 need not have a very low value in order to achieve a good high frequency response.

Fig. 7 shows the circuit of a typical cathode follower stage. The junction of R_2 and R_3 is chosen to provide the correct bias for the valve for the current required. R_1 is the normal grid return required to keep the grid at the correct voltage. The value of C_1 would normally be chosen so that during a cycle of the lowest frequency to be passed, C_1 would not be appreciably discharged by R_1. However, in this case, if a signal appears at the grid of the valve V_g then nearly the same amplitude of signal appears at the cathode V_K. The voltage across R_1 is therefore not V_g but V_g–V_K and therefore the a.c. current through R_1 is very appreciably reduced. From the point of view of the input, therefore, very much less a.c. current is taken by R_1, and this means that the value of R_1 appears to be much larger than it actually is. In a practical case the value of R_1 is actually 500kΩ but appears to be in the order of 5MΩ. The value of C_1 may therefore be reduced for the same low frequency response. More important, the input capacitance of the stage also appears to be less in the same way.

Advantage is taken of this fact to reduce the effects of the screened cable coupling VR_2 to the grid of the cathode follower stage. The capacity of this cable is approximately 30pF, but since the screened outer is made to follow the input signal by connecting it to the cathode of the cathode follower stage, the capacity of this cable will therefore only appear to be about 5pF (see C_2 in Fig. 7). This means that for the same high frequency response the value of VR_2 can be higher and in fact no alteration in shape of the square wave at 100 kc/s is observed when attenuator VR_2 is adjusted. It is necessary for this value to be reasonably high to prevent overloading the Wien bridge amplifier V_{2A}. However, VR_2 must be reasonably low—in fact 50kΩ is chosen—and this therefore raises problems of low frequency response. It will be seen that the coupling C_5 is in fact a 16μF electrolytic condenser. The potentiometer VR_3 allows the exact setting of the voltage output as explained in the section on testing the generator.

Notes on Mechanical Assembly

The assembly follows normal practice for

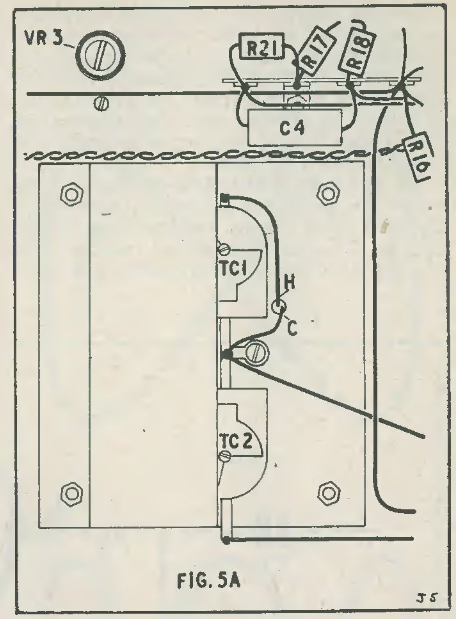


FIG. 5A

fixing valveholders, tagstrips, etc., the details being given on Figs. 3 to 6, and only a few points require explanation.

(*a*) *The Tuning Condenser*.—Because the frame of this component must be insulated from the chassis, it is mounted on a paxolin insulator held to the underside of the chassis by means of a 6BA screw at each corner. The paxolin should first be mounted on the chassis and then the trimmers TC_1 and TC_2 screwed to the underside, as shown on Fig. 5. The tuning condenser is held in place by means of three 4BA screws passing through the ¼in spacers which hold the condenser at the correct height above the chassis. The polystyrene spindle should be coupled to the condenser spindle by means of the coupler and centred where it passes through the chassis front panel before the condenser is tightened down.

(*b*) Resistors R_1 to R_8 and flying leads of adequate length, as shown on the detail switch drawings, Fig. 6 should be soldered to switch S_1 before it is screwed to the chassis front panel. This also applies to resistors R_{28} to R_{35} and switch S_3.

(*c*) The coaxial output socket is spaced away from the chassis with two 4BA nuts which fit loosely over the 6BA fixing screws.

(*d*) $\frac{3}{16}$in long 6BA screws are used for fixing the two preset variable resistors. These must not be longer, or they will lock the centre of the potentiometer.

(*e*) The fixing of the frame surround casting is best left until wiring is complete, when it can be screwed to the chassis with 4BA screws through the recessed holes at each corner of the casting. 4BA spring nuts can then be slipped over the appropriate drilled thin flanges to correspond with the fixing holes on the scale.

(*f*) The cover is fitted into the slot running round the rear of the casting and screwed to the 4BA hank bushes on the sides of the chassis. The expanded metal mesh on the bottom of the case is tightened after assembly.

Wiring Procedure

(*a*) Earth the centre spigot and appropriate pins on each valveholder to a soldering tag as shown in Fig. 5. In general, this can be done with bare wire.

(*b*) Run the wire connections as shown on the wiring diagram. Connections running from the underside to the top of the chassis are lettered to facilitate tracing.

(*c*) The remaining resistors and condensers can now be wired in place.

Testing Procedure

(*a*) Check all wiring thoroughly. An

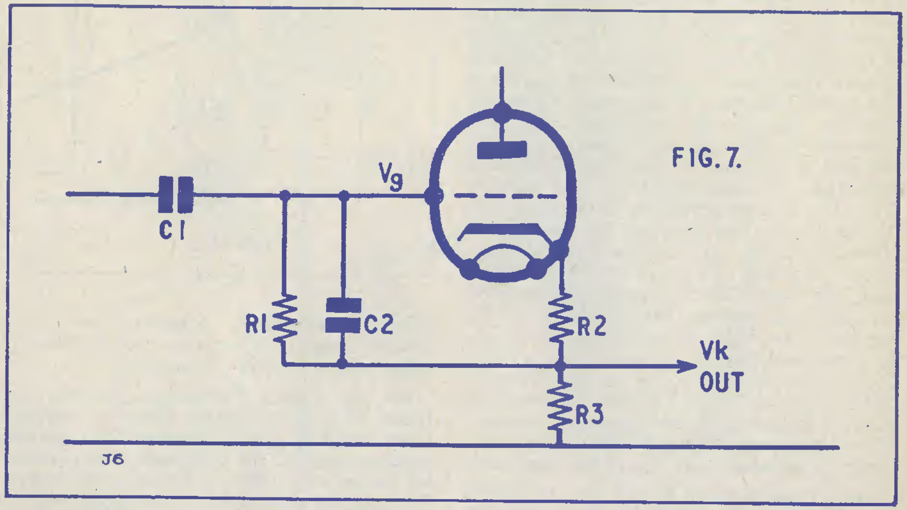


FIG. 7.

Wiring Notes

(*a*) The components shown on the wiring diagram Fig. 5 are not necessarily drawn to scale, but indicate the connection and appropriate position taken up by each component.

(*b*) As the physical disposition of components and connections can sometimes affect performance, the wiring diagram should be followed during assembly, but to gain familiarity with the instrument it should, at every stage of the assembly, be compared with the circuit diagram.

(*c*) Wires and component leads should be pushed through and wrapped around tags and valveholder pins to ensure a firm mechanical connection. No tag or valveholder pin should be soldered until all the leads and components on that particular tag are in place and have been checked.

(*d*) Connecting wires should be straight with sharp distinct bends and be run flat touching the chassis.

ohmmeter connected between the chassis and the junction of R_{27} and C_{8B} should read about 40kΩ.

(*b*) On switching on, the following voltages should be obtained, with S_2 set to "sine" and VR_2 rotated anti-clockwise:

Junction R_{27}	C_{8A}	315V	
Junction R_{27},	C_{8B}	245V	
V_1	Pin 1	5.5V	
V_1	Pin 7	150V	
V_1	Pin 8	240V	
V_2	Pin 1	245V	
V_2	Pin 3	245V	
V_2	Pin 6	135V	
V_2	Pin 7	3V	
V_2	Pin 8	68V	
		sine	square
V_3	Pin 1	60V	124V
V_3	Pin 3	80V	72V
V_3	Pin 6	250V	180V
V_3	Pins 7, 8	27V	25V

Alignment

The most accurate method of alignment for the home constructor is as follows:

An oscilloscope which incorporates a sine wave sweep derived from the mains, or which can be temporarily modified, is needed.

With the generator switched to sine wave output on the range 100 c/s to 1 kc/s, Lissajou's figures (Fig. 8) can be seen on the oscilloscope screen. Set TC_1 and TC_2 so that the rotor datum mark lies at 10 o'clock to the fixed datum line.

With the pointer set to somewhere near the 100 c/s mark on the scale, a stationary figure similar to Fig. 8 (*a*) will be obtained. In the region of the 150 c/s and 200 c/s marks figures as at Fig. 8 (*b*) and 8 (*c*) will be obtained, and thereafter at the 250 c/s, 300 c/s, etc., position up to the 1 kc/s mark. By counting the number of stationary figures obtained from an easily identifiable lower frequency figure, the one corresponding to 1 kc/s can be identified. By turning TC_1 and TC_2 by the same amount either clockwise or anti-clockwise, this figure can be made to coincide with the 1 kc/s mark on the scale. In all probability the scale will not read correctly at the low frequency end of the scale. The coupling bush on the condenser should be slackened and the pointer moved until it points to the correct point on the scale. By repeating this procedure a number of times, it will be found that the stationary Lissajou's figures can be made to coincide with the correct tuning points on the scale. When this has been done, the other ranges will be automatically set.

To set the output voltage, set the generator to 50 c/s and connect an a.c. voltmeter (with a 1,000 ohm per volt movement) to the generator output. Switch the attenuator to 1V and the multiplier to 10 and adjust VR_3 until the meter reads 10V. On turning the multiplier to 1, the meter should read 1V; if it does not, slacken the potentiometer locking nut and alternately adjust the position of the potentiometer and VR_3 until the correct readings are obtained.

Hum Checking

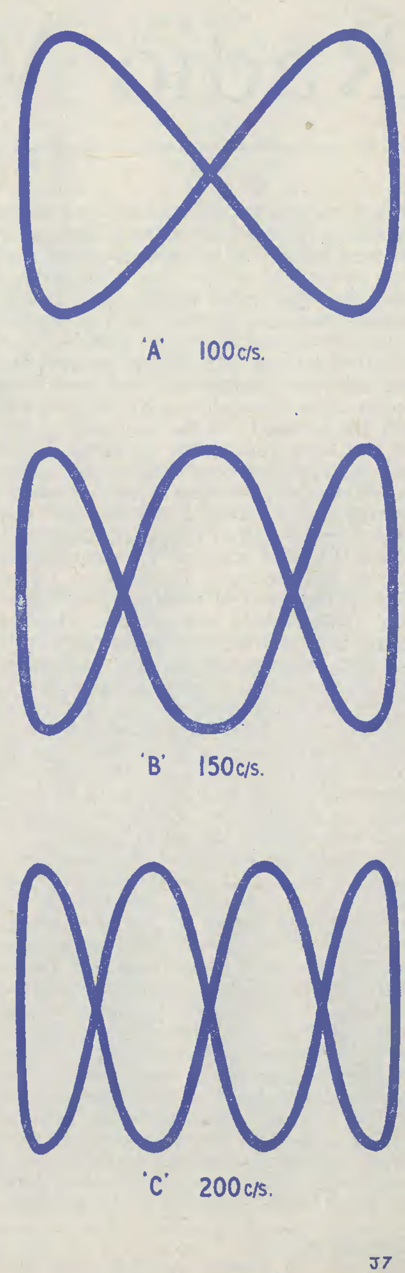
Set the generator to a few cycles above or below 50 c/s. A slow change of amplitude may now be seen at a speed of 3–6 c/s This is caused by hum pick-up in the valve and associated circuit. This hum may be removed by adjusting the humdinger VR_4.

Alignment the Easy Way

The Jason Motor & Electronic Company will undertake to test the generator and align the scale providing that the layout diagram has been followed carefully.

It should be emphasised that the component parts should be obtained from a supplier retailing either Jason or other manufacturers' equivalents, which are "designer approved."

FIG. 8.



Radio Miscellany

Centre Tap talks about items of general interest

Since touching upon the use of gramophone records as a means of learning to read Morse, quite a few enquiries have come to hand as to the value of this system—and also one or two asking about foreign language records. As both sorts of records are fairly expensive, it is perhaps only natural that those with shallow purses are a little cautious. Sometimes, too, one hears reports about those who have tried them and been disappointed. In the few cases of this sort that have come within my direct experience, the fault has been entirely that of the user. The mere possession of, and occasional listening to, the record is not enough. One still has to concentrate pretty conscientiously and put in a lot of practice. The records make it easier, but not easy. This opinion, I must admit, is the result of other people's experience. It was a long time ago that I learned Morse, but I can well remember finding it a long and disheartening process. Somehow, I could never find transmissions at speeds suitable for me to practise, and on the rare occasions when I did I just didn't feel like it. Hence there was a shocking amount of time wasted, and even when I got the hang of it I discovered I still had quite a bit to do to polish up my style and eliminate the faults which lone learners are apt to acquire.

Practically all self-taught operators get a nasty jolt when they test themselves on an inker-tape. Bad grouping, bad spacing and both dots and dashes of irregular length, apart from erratic speeds, may occur even in the same sentence. By learning from perfect "copy" a good style is acquired right from the start. Those who have learned their code from records by conscientious practice invariably speak highly of their value. Incidentally, I see that a blind Bedfast Club member, James Padly of Worthing, has just qualified for his amateur ticket (call-sign G3NHJ). He also found the loan of some Morse records of considerable value, and if you imagine Morse is difficult—just think how much harder it must be for the sightless.

Speak Easy!

As for the smaller number who have enquired about language records, I must confess my slight linguistic knowledge was not acquired via records. I have always been convinced that the most useful help I received in the beginner stage was from the children of Continental amateurs I visited. Even those who make no conscious effort to learn anything of the language, and are satisfied to get by with English helped out with a little Radioese, pick up a few phrases off the kids. They talk more clearly than adults, and talk much more of simple, homely things, often using helpful action. I should, of course, make it clear that I am talking of languages purely from a "conversational" point of view and not from the student angle. After all, how many people can correctly define the genitive, dative and other cases in their own language a few years after leaving school?

For conversational languages I would say the best substitute for a couple of foreign children is the gramophone, but once again concentrated study and some textbook work is essential. Recently I have heard two makes of such records and there are, I believe, others, including one very cheap one for those who want a smattering of travel phrases. With these the inflection and pronunciation was, naturally, perfect, but somehow the matter in them seemed to my mind rather stilted and remote from everyday life. For instance, I can hardly imagine myself wanting to say "I am a construction worker. I work on a construction job," or "Did the Fire Brigade take everybody to safety?".

Maybe I ought to have been more cautious about my limited linguistic powers. Two of my letters this month were from Germany—in German! *R.C.* does get around! One of them may be of special interest to a few readers. A new radio periodical appeared there at the end of February called *Der Kurzwellenhörer* (The Short-Wave Listener). Perhaps an unfortunate choice of title to British ears, as over here there was a monthly of that name which petered out after a comparatively brief run. I haven't yet seen a copy, but I gather a special feature is to be provision for a pleasant and gentle transition from SWL to a full transmitting licence. A "Lehrgang" (course of instruction) with the minimum formulae and the maximum "Rüstzeug" (for which I can't find a satisfactory equivalent) to enable success in the "Prüfing" (examination) for transmitting licences. As if radio isn't difficult enough for beginners without doing it in another language. It seems rather like tearing up a copy of the local bye-laws and trying to put it together again by the sense of the wording!

Hi-Lo-Hi-Fi

An interesting letter comes from B.A.W. (Balham, S.W.12) who has recently had a spell in hospital where he, also, found the disadvantages partially compensated for by the escape from the monotonous round of the t.v. programme cycle. Quietly enjoying a recital of gramophone request music, he was deeply impressed with a record of "Fantastica—Music from Outer Space," and immediately decided to get a copy for his own gramo. library. His wife tried quite a number of shops for him, only to be told that they had never heard of it and couldn't find it in the catalogues. Finally, however, a knowledgeable assistant in a small shop quickly identified it and was able to supply the number (London HA-U 2141).

The makers claim that it was recorded with the engineers and composer in close co-operation, and that sounds as low as 16 c/s are to be heard in "Lost Souls of Saturn" and as high as 22,000 c/s in "Monsters of Jupiter." B.A.W. hopes the foregoing will be of interest to "Aberdonian" and finishes up with a recommendation also for F.N. (Derby)—Vaughan Williams's overture "The Wasps" which also has merit as a test piece. Thanks for the nice letter, O.M. By the way, aren't you the keen collector of British and American radio periodicals ranging from the early days? Or are my ageing faculties getting confused?

While still on the subject of gramo. discs, G.A.N. (London Airport) returns to the fray after having been to some trouble to confirm his facts *re* the quality and manufacture of "World" records. He can confirm they are made in the same concert halls and recording studios and by the same technicians as the major companies. After recording they are processed by a contractor who presses many of the leading labels. As a result these records are in no way physically different from those sold at a much higher price. The economies are effected in the distribution.

Well, we seem to be back to where we started. Especially so, since a local friend who has belatedly joined in the argument brought round half-a-dozen selected top price records which could well be faulted. After the demonstration he insisted that I should print it in this column this month. Duty done!

My flippant hint last month that a hi-fi-minded Chancellor might make a reduction in Purchase Tax on gramophone records had but little effect. Perhaps, after all, he isn't hi-fi-minded—at least he did not single out records for special relief, but they do qualify in the general reduction from 60% to 50%. This makes a saving of about 2s. on a £2 long play.

From the contractor's viewpoint the reduction in P.T. of nearly a third of the cost on "replacement" t.v. tubes is better news. And there is nothing to prevent us from holding our hands out again in readiness for the next Budget!

Upon Reflection

My comments on Heaviside and the absence of honour accorded to his name in U.S. radio literature brought in only one reply quoting an instance of the use of his name in referring to the lower ionized layer. Even in this case Heaviside's name is placed in a secondary position to that of Kennelly with whom it is coupled. This letter was from J.M. (Hayes, Middlesex) who referred me to a McGraw Hill book *Principles of Radio Engineering* (published 1936) which speaks of it as the Kennelly-Heaviside layer.

Good work, J.M. I have since checked on a further couple of American books, and in each case the respective layers, upper and lower, are invariably called the E and F layers respectively.

It is only when enthusiasts become keen on Dx listening that they take any real interest in the Heaviside and Appleton Layers and their behaviour. The lower layer varies in height with an average of about 70 miles and reaches its maximum intensity around midday. After sundown it is but weakly ionized. The upper layer varies to a more marked extent with the season of the year and is about 185 miles above the earth's surface in winter and 250 in summer. During daylight hours it splits into two when, in American radio literature, the two layers are classified as F1 and F2. After darkness they merge into one.

Both, of course, reflect radio signals of a given range of frequencies back to earth instead of allowing them to escape into space, hence the importance of their behaviour to the short-wave enthusiast. However, they do not always follow the "book of form." Many of my own gems of Dx occurred at the wrong time according to the rules. These instances, of course, were due to sun-spot activity and the like, but perhaps it is just this uncertainty which adds zest to remote flea-power-station searching—especially when it comes off.

Impossible People

Some years back I told of a new t.v. viewer who had proudly installed his newly acquired set—his first. Carefully explaining how he did it, he said "It has two little aerial socket holes in the back." Teasingly I said "But there is only one programme to receive." I.T.V. hadn't started then. "You must have two," he solemnly assured me, "one for the picture and one for the sound."

Well, there are still plenty more of them around, the latest being—

—the bright handyman who apparently still had muddled memories of his schooldays' *Electricity and Magnetism.* Living in a "fringe area," he fitted magnets to his t.v. aerial to attract a stronger signal!

—the dear old soul whose t.v. suffered from lack of brightness and thought the inside needed cleaning out as the tube must be getting "choked up" with the bodies of dead cowboys and Indians!

1959 THE LONDON AUDIO FAIR

This year the Audio Fair was held, from 2nd to 5th April inclusive, at the Russell Hotel. The Fair is becoming of such a size that it is virtually impossible for any correspondent to cover it adequately, so the impressions of equally interested friends were welcome.

The common impression was that a large number of demonstrators were using a Decca cartridge to play stereo discs; and let's face it, this was a stereo Audio Fair. Nevertheless the common feeling, again, was one of disappointment. The writer has always held the opinion that tape was the medium for stereo, and was pleased to find support from non-tape enthusiasts.

A new disc label was seen, *Audio Fidelity*, their American origin proclaimed by the jacket designs. The recording quality sounded fair, but no judgment could be truly made under the conditions existing.

A visit to the S.T.C. stand proved interesting. Details were obtained of two new audio valves, the 8D8, a low noise amplifier pentode, and the 6BR8, an audio based version of the PCF82. Also displayed on this stand were the full range of S.T.C. microphones (including the one that occasionally bobs down at the top of your t.v. picture). These products, previously restricted in their sale, are now generally available. The serious enthusiast who wants a top quality microphone and is prepared to pay for a professional instrument need go no farther.

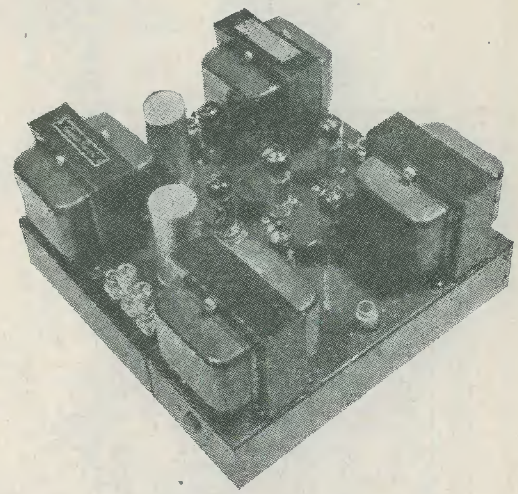
The world of tape recording saw some new names. Trix have two portable tape recorders to offer, a two-speed (3¾in and 7½in) machine using a Continental deck, and a smaller machine with the single tape speed of 3¾in/sec. The latter model uses the new BSR tape deck and performs quite well, particularly in view of a very attractive price. These machines are mains driven, and should perhaps be termed "transportable" since the advent of the "Fi-cord," a battery-driven, transistorised machine that is not a toy. Your correspondent heard it reproduce music at 7½in/sec, through an external amplifier and speaker, that would put to shame several conventional models. Grundig were demonstrating a prototype of the stereo model that many people will have been waiting for. The styling and performance were such as is expected from this marque.

Turning to the "power house" end of audio, the amplifier and reproducer, the choice is as bewildering as ever. Twin (stereo) amplifiers are now obtainable from all the well-known names, and the necessary pre-amplifiers show the thought and care in design that is warranted. In this connection the Jason kits and a new publication of Mullards were popular amongst those who doubtless hoped to effect some small economy by doing it themselves. The loudspeaker manufacturers are, of course, quite prepared to sell you two units where you would only have purchased one a year or two ago.

Finally, a word about the programme, excellently produced, with some most interesting historical notes amongst the introductory items.

A.B.S.

CONVERSION OF THE "PRODIGY" to STEREO



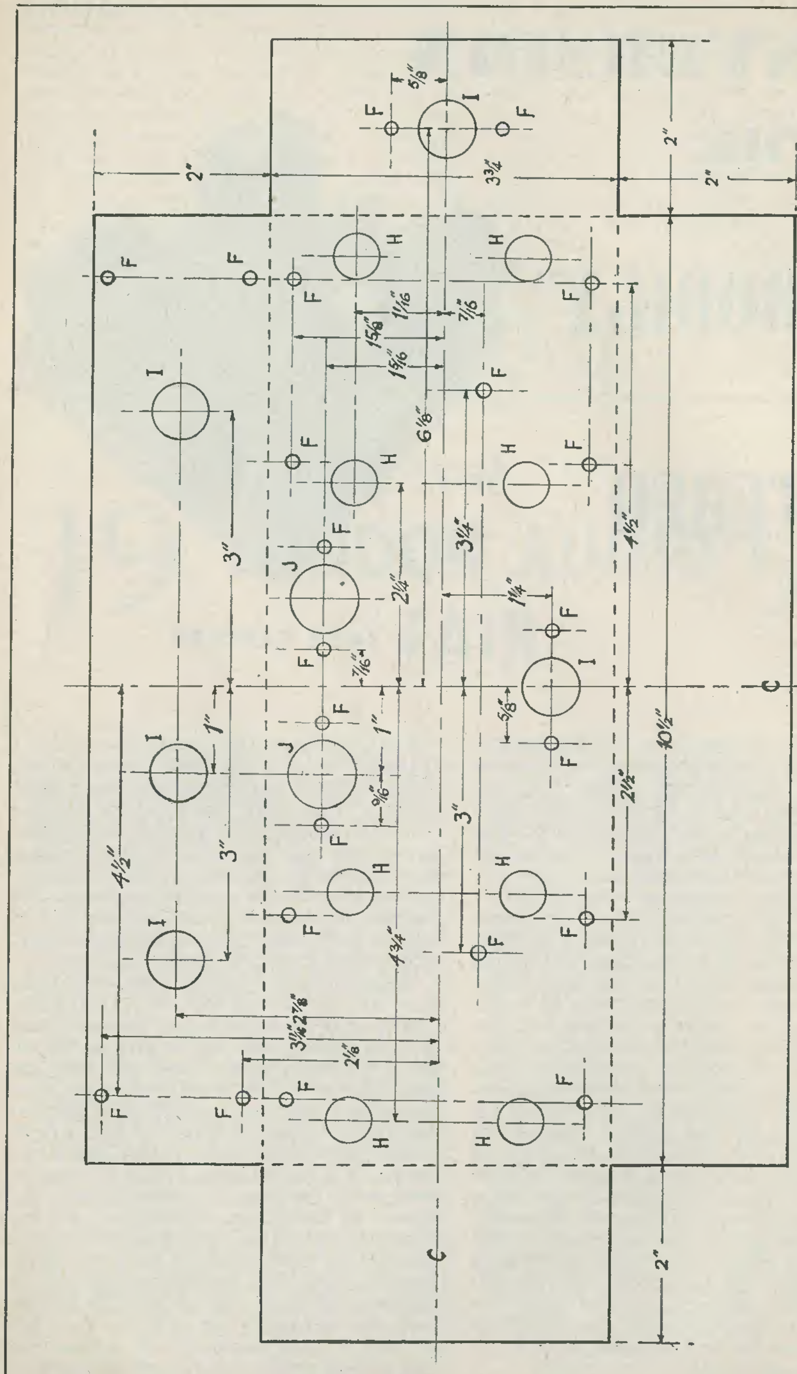
By JACK COOPER

STEREO IS NOT A "GIMMICK"! It represents the greatest advance in sound reproduction since designers started on the road to perfection, and there is no doubt in my mind that the day will come when no reproducer will be considered "hi-fi" unless it *is* stereophonic.

I trust that owners of the "Prodigy" amplifier (present and future) will not be put off converting to stereo as a result of listening to some of the so-called stereo set-ups at present on the market. I am afraid that certain manufacturers have done a lot to kill stereo from the start by rushing into the market with equipment which, while employing basic stereophonic principles, fails miserably because the minimum requirements of real stereophonic reproduction are too expensive for the popular market. In other words, they have taken advantage of the fact that stereo gives a more realistic effect and have tried to get away with using inferior equipment. This, to the discerning listener, cancels out the advantage of the stereophonic effect. They did a similar thing with television and f.m., taking the view that as f.m., for instance, provided a greater frequency range and lower distortion than a.m. they could afford to waste some of the benefits by using cheaper components!

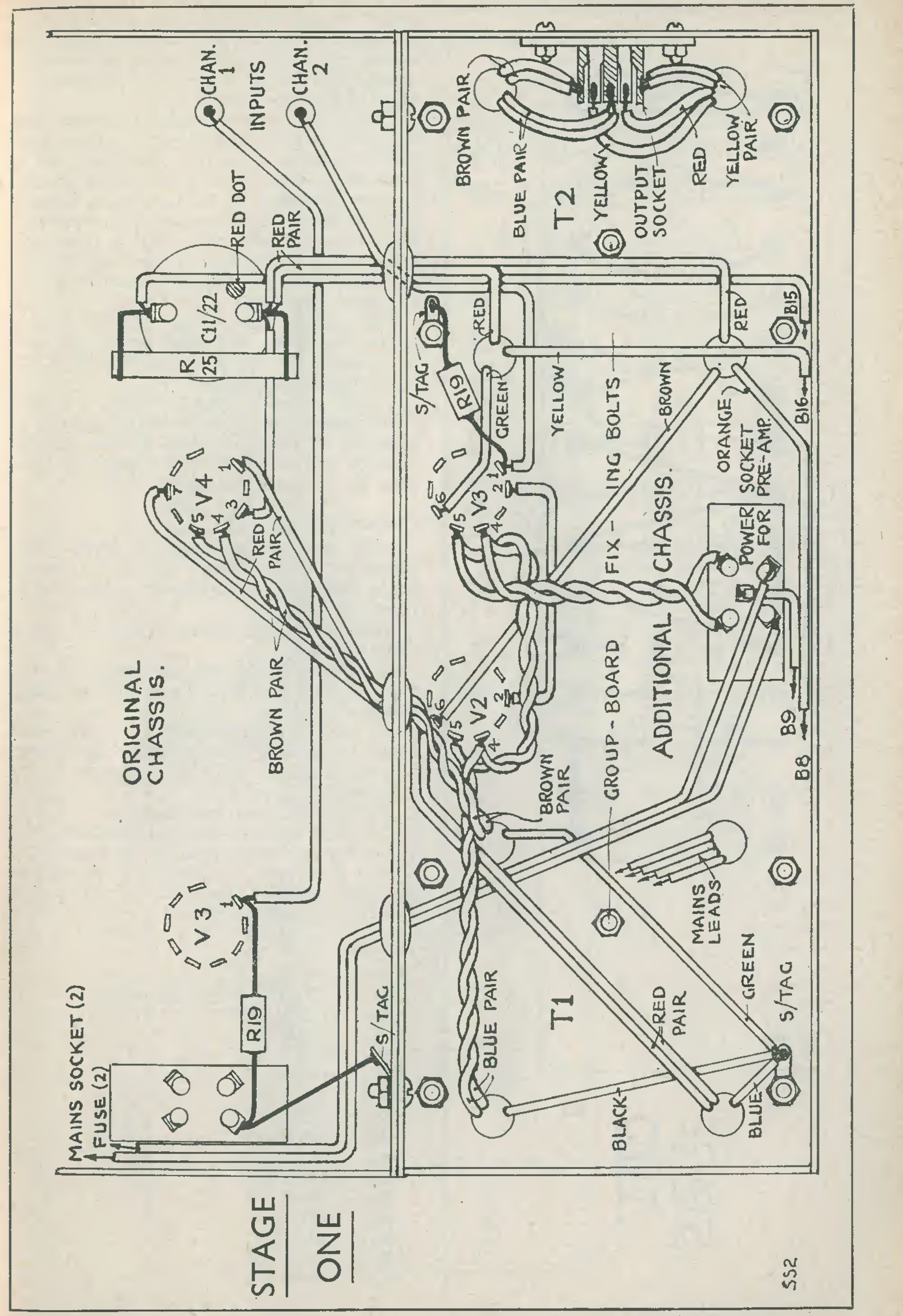
This is where the proud owner of a "Prodigy" scores. By doubling up on his already efficient equipment, and using good, properly sited twin loudspeakers, he can more than double the realism of his reproduction at little more than the cost of a first-class monaural outfit. By the use of the "add-on" unit about to be described he can ensure that the first requirement of a stereo amplifier is fulfilled in that each channel will be matched, especially as regards frequency response.

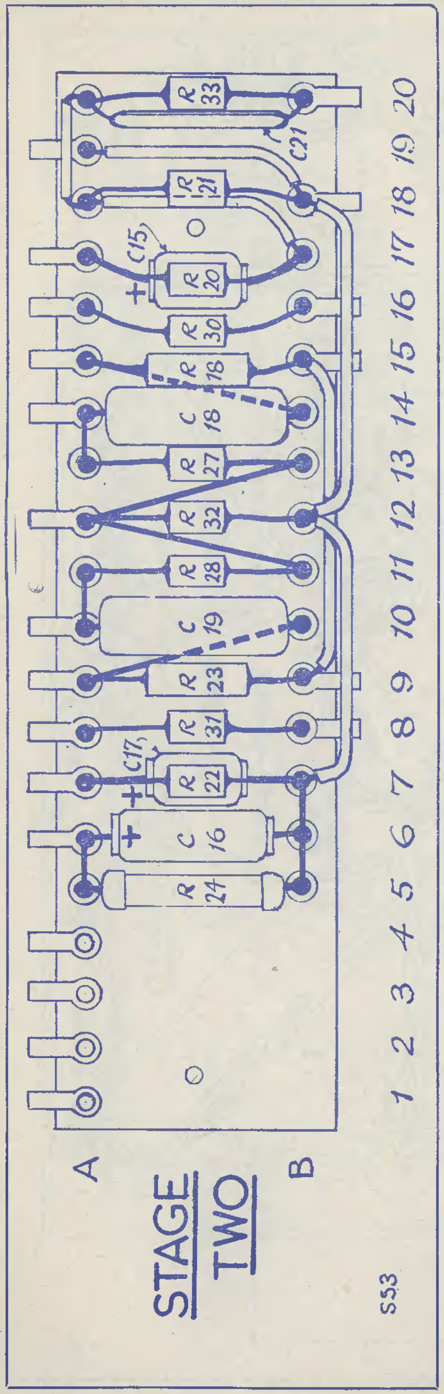
Unfortunately, it will be necessary to do away with the existing controls, as real stereo cannot be obtained with separate sets of tone controls; these must be ganged, so that at any given setting both channels are doing the same amount of work at *all frequencies.* With unmatched tone controls the most peculiar disembodied sound will result. This will be readily understood if one realises how stereo works. Let us imagine a soloist standing dead centre on stage. In order to make him *appear* to be in the centre (i.e. midway between your two speakers) the sound intensity of both channels must be equal. Now if, say, the right-hand speaker is delivering more output at *high* frequencies than the left-hand one the soloist, when playing in the middle of his range, may appear dead centre, but when changing to the



F = 4BA Clearance. H = ½" Dia. I = ⅝" Dia. J = ¾" Dia.

UNDERSIDE of CHASSIS Bend UP at dotted lines.





higher register will appear to move over to the right! This may not be very important in the case of the soloist (some move about anyway) but what of a whole violin section of a symphony orchestra?

This is why we have designed a special and separate stereo control unit using dual potentiometers. It is not essential, but is more convenient, to have the volume control ganged and this we have done, adding a balance control which makes up for inequalities in output of signal sources (pick-ups, records and tape heads) by adjusting the gain of one channel without modifying the frequency response.

This control unit will be described in a subsequent issue, and incidentally, will also be suitable for use with two Model B.P.I. Cooper-Smith amplifiers.

I repeat, stereo is not a gimmick, and when all the rules have been observed is capable of bringing to the ear of the listener greater breadth and beauty of sound than was ever possible on monaural equipment.

Construction

First remove the controls from your "Prodigy" (VR_1, VR_2, VR_3, $S_{1/2}$) and all leads, resistors and capacitors connected to them.

Remove busbar (Radio input to power output socket).

Remove resistors and capacitors C_1, C_7, R_9, C_8, R_{13}, R_{11}, R_{10}, C_6, R_{12} from group board.

Fit new valveholder at V_1 position or remove all connections including bridge between 4 and 5. (This now becomes V_4 for Channel 2.)

Remove dial lamp and leads.

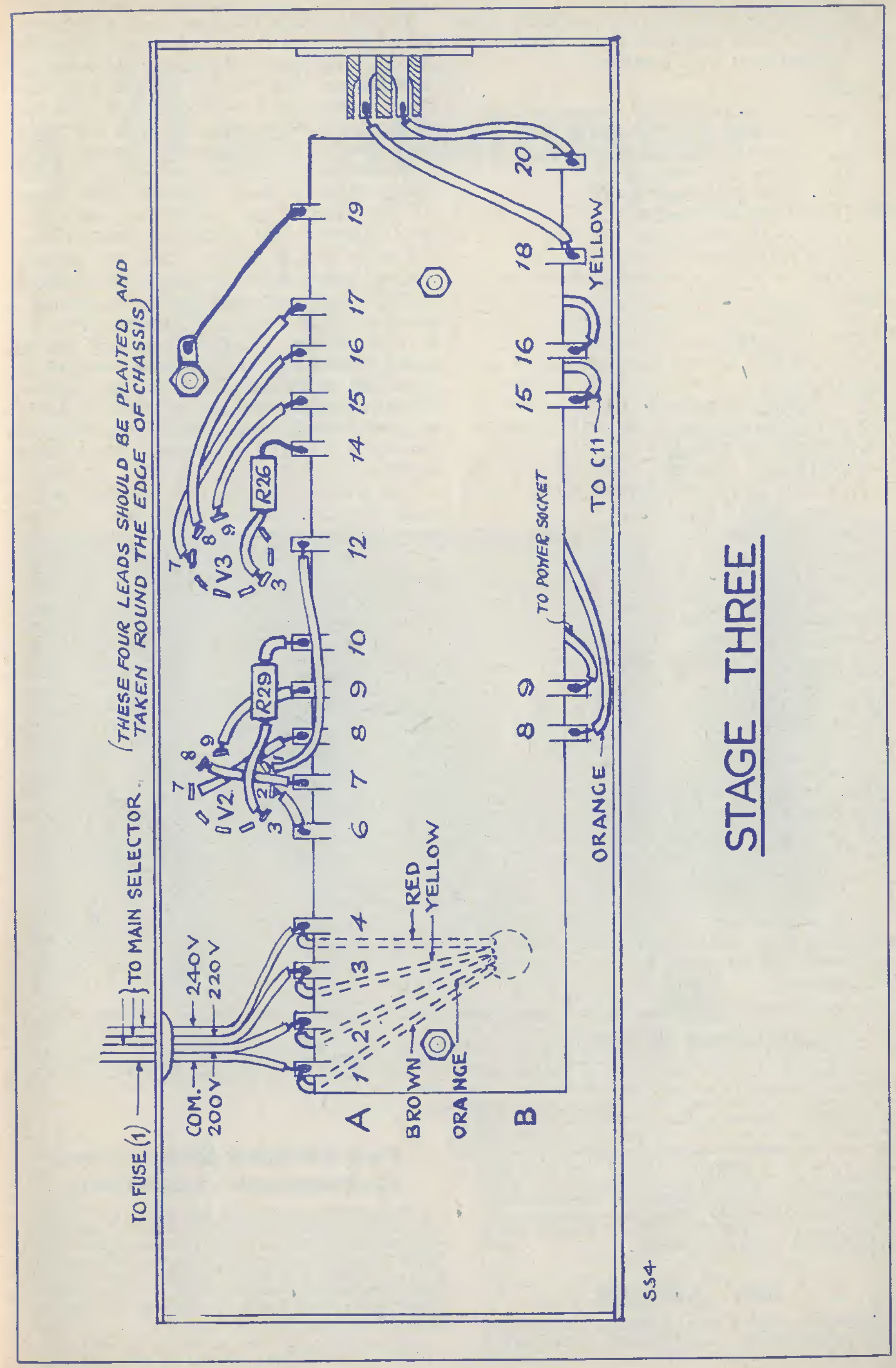
Do NOT remove earth connection from solder tag on Radio input to tag board.

You now have Channel 1 of your main amplifier and are ready to add Channel 2. For this you will require:

Resistors

*R_{18}	100kΩ ½W
R_{19}	270kΩ ¼W (see below)
R_{20}	1.2kΩ ¼W
R_{21}	100Ω ¼W
R_{22}	1.2kΩ ¼W
*R_{23}	100kΩ ½W
R_{24}	390Ω 5W
R_{25}	2.2kΩ 1W
R_{26}	10kΩ ¼W
*R_{27}	1MΩ ¼W
*R_{28}	1MΩ ¼W
R_{29}	10kΩ ¼W
R_{30}	47Ω ¼W
R_{31}	47Ω ¼W
*R_{32}	1MΩ ¼W
R_{33}	680Ω ¼W

**Matched to within 5%*



Note.—R_{19} in the original amplifier was fitted on V_3, and as it now has to be refitted, it is advisable to get a new one.

Condensers

- $C_{11, 12}$ 50+50μF 350V electrolytic and clip
- C_{15} 50μF 12V electrolytic
- C_{16} 50μF 25V electrolytic
- C_{17} 50μF 12V electrolytic
- C_{18} 0.1μF 350V paper
- C_{19} 0.1μF 350V paper
- C_{21} 3,000pF mica 20%

Valves

- V_2 ECL82
- V_3 ECL82
- V_4 EZ81

Miscellaneous

- T_1 Mains transformer
- T_2 Output transformer
- Group board, 20-way
- Valveholders, B9A (3)
- Plugs and sockets, 5-pin (2)
- Chassis 10½in x 3⅞in x 2in
- Grommets (11)
- Solder tags, 4BA (3)
- Nuts and bolts, 4BA (14)
- Nuts and bolts, 4BA, long (2) with 6 nuts
- Nuts and bolts, 6BA (8)
- Sleeving (2 yds)
- 22 s.w.g. T/C wire (2½ yds)
- Flex, brown (1½ft)
- Flex, orange (1½ft)
- Flex, red (1½ft)
- Flex, yellow (1½ft)

All chassis made for the "Prodigy" since it was decided to introduce an add-on unit have had four holes drilled in the front to take the fixing bolts for the latter. Chassis made previously to this will have to be drilled. Provision has also been made for fixing $C_{11/12}$ (push-out disc near selector switch). If unable to cut out a hole this size please ask for a side mounting clip which will enable this component to be fixed underneath the chassis.

Having bolted the two chassis together, insert grommets in the holes used originally for $S_{1/2}$, VR_1 and VR_3 and in the holes for transformer leads. Next fit the two long bolts to hold the group board, then the rest of the components (not forgetting the solder tags) with the exception of the group board.

Now wire up as shown in wiring diagram "Stage One." Note that the two inputs "Radio" and "Tape" are now used as inputs for Channels 1 and 2 from the Pre-amplifier.

Check wiring against that of existing channel which should, of course, be identical.

The mains lead from T_1 and leads shown going to B8, B9, B15 and B16 should be left in a convenient position for fixing to the group board, which should now be wired up as shown in "Stage Two" wiring diagram. The components will be the same as on the original with the exception of R_{25} (and, of course, C_{20} and R_{34}) but not in the same order.

The group board can now be fitted on the bolts provided (with spacing nuts) and the wiring finished off as shown in "Stage Three" wiring diagram and again checked against the original. The main Stereo Amplifier is now completed.

It has been found that in some cases where the full current is not being drawn from the power supply (i.e. from the power output socket), the h.t. voltage tends to become excessive. We therefore recommend that a resistor of approximately 500Ω 5 watts be connected between the cathode (pin 3) of the rectifier (V_4) and C_{22}. The wire connecting these two points should be removed and the resistor fitted in its place. This will have the effect of correcting the tendency of the large capacity reservoir condenser to raise the d.c. voltage.

Any "Prodigy" owner will be sent the necessary resistor free of charge on receipt of a 3d. stamp for return postage, by H. L. Smith & Co. Ltd., 287–289 Edgware Road, London, W.2.

Interested in RTTY?

Sufficient interest has been shown in the amateur teletype articles which we have published to warrant the formation of a Teletype Group. It is hoped to issue periodically a newsheet to keep members of the Group in touch with one another, and to build up within the Group information on supplies of equipment, circuitry, and so on. It is particularly hoped that those with practical experience of teletype will join the Group and give other members the advantage of their knowledge.

Will those interested please write direct to Dr. Arthur C. Gee, G2UK, "East Keal," Romany Road, Oulton Broad, Lowestoft, Suffolk.

New Address

Mayra Electronics Limited announce that the exceptional popularity of their "Maykit" Do-It-Yourself Car Radio has made it necessary for them to take larger accommodation than was available at 551 Holloway Road, N.19, and a new office and showroom has been opened at 118 Brighton Road, Purley, Surrey, telephone BYWood 1263.

Two Mullard Designs for Stereophonic Amplifiers

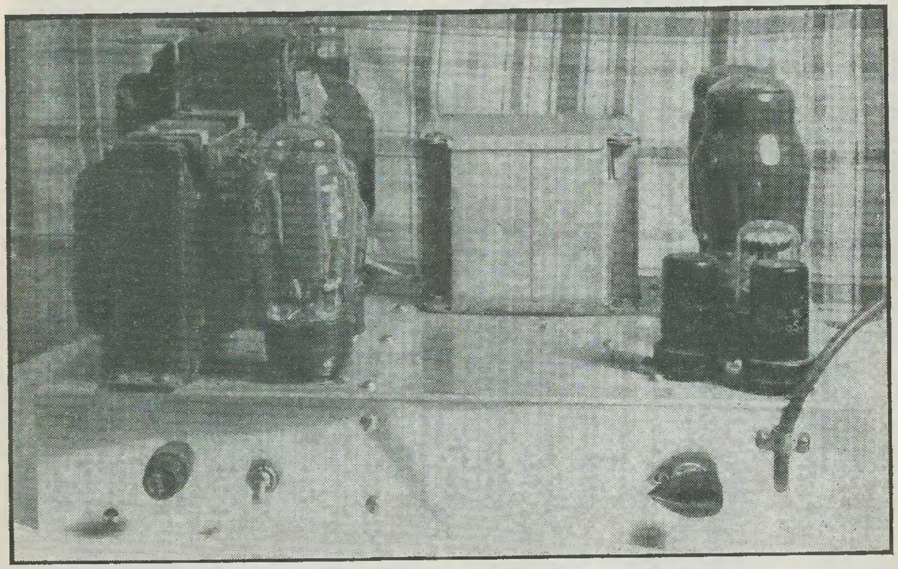
The 7-watt amplifier, using 2-ECL82 valves for each channel, aims at high quality with minimum distortion level, whilst the second circuit will be of interest to constructors to whom cost is the primary consideration; both are described in leaflet TP386A. Supplies of this publication can be obtained on request to Mr. R. Webb, Home Trade Sales Division, Mullard Ltd., Mullard House, Torrington Place, London, W.C.1.

Further copies of the leaflet *Valves and Semi-Conductors for the Radio Amateur* are now available.

a 30-watt modulator

By E. H. TROWELL, G2HKU

THIS MODULATOR WAS DESIGNED FOR USE with a transmitter using the popular 807 as its PA valve. The maximum rating for the 807 in ICAS service (an American rating meaning Intermittent Commercial and Amateur Service) is 75 watts CW and 60 watts telephony. Thus, for full 100% anode modulation the modulator must be capable of supplying an audio frequency power of 30 watts, and such a circuit is shown in Fig. 1.



Front view of the 30-*watt modulator*

Circuit

There is nothing unusual about the circuit itself, although the balancing network of C_{12} and P_2 will perhaps not be familiar to some readers. V_1 is the speech amplifier and the circuit is arranged for a crystal microphone input. R_1 has a decided bearing on the frequency response of the microphone, some types of which have the value of the input grid resistor marked inside the case. For perfect matching reference should be made to the microphone manufacturer to ascertain this value, although that shown appears to be average. The low frequency response will be attenuated by the use of a low value grid resistor. This stage is resistance-capacity coupled to V_2, and adequate gain is developed to drive the third stage V_{3A} and V_{3B} which is the phase inverter.

The action of this stage is to apply a voltage at the grid of V_5 which is 180° out of phase with that being applied to the grid of V_4. It is essential that the drive being applied to both valves should be equal, and in order to obtain this easily a manual adjustment control P_2 is provided, the adjustment of which is discussed later.

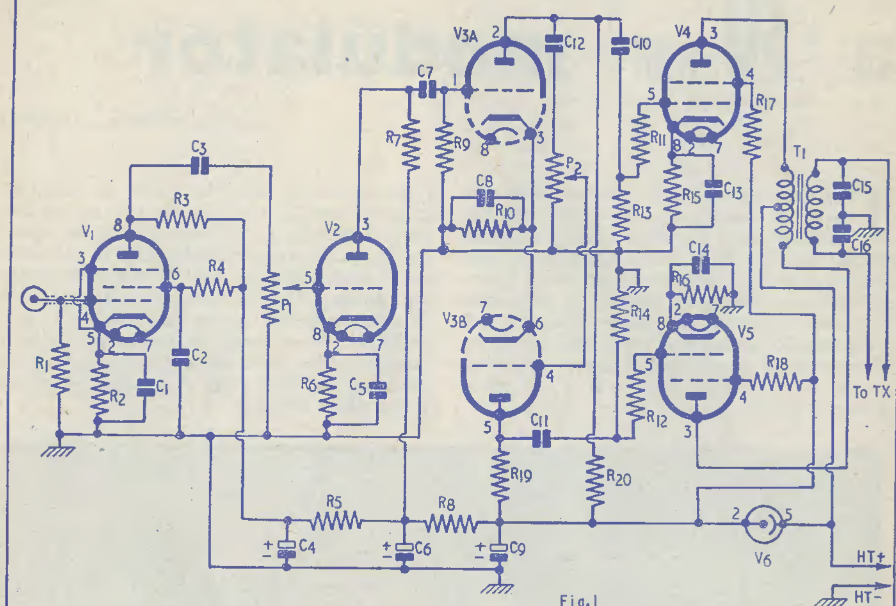


Fig. 1
A 30W modulator

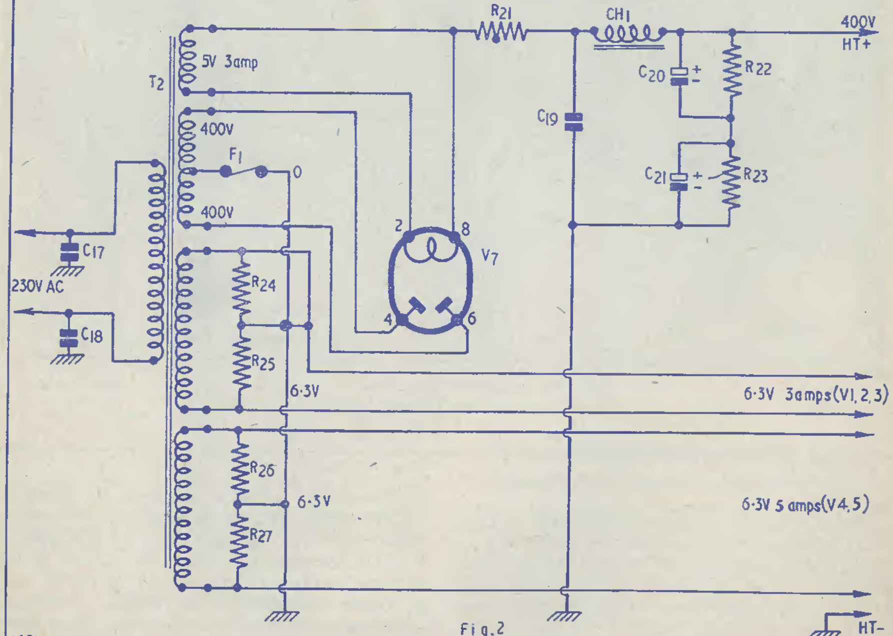


Fig. 2
Power supply

COMPONENTS LIST
(Modulator)

Resistors

R_1	2MΩ ¼W
R_2	1.5kΩ ½W
R_3	220kΩ ¼W
R_4	1MΩ ¼W
R_5	33kΩ 1W
R_6	1.5kΩ ½W
R_7	47kΩ ½W
R_8	12kΩ 1W
R_9	250kΩ ¼W
R_{10}	1.5kΩ ½W
R_{11}	4.7kΩ ½W
R_{12}	4.7kΩ ½W
R_{13}	220kΩ ½W
R_{14}	220kΩ ½W
R_{15}	500Ω 5W
R_{16}	500Ω 5W
R_{17}	100Ω ½W
R_{18}	100Ω ½W
R_{19}	50kΩ ½W
R_{20}	50kΩ ½W

Condensers

C_1	25μF 25V elect.
C_2	0.1μF 350V
C_3	0.05μF 350V
C_4	8μF 500V elect.
C_5	25μF 25V elect.
C_6	8μF 500V elect.
C_7	0.05μF 350V
C_8	25μF 25V elect.
C_9	8μF 500V elect.
C_{10}	0.1μF 350V
C_{11}	0.1μF 350V
C_{12}	0.01μF 350V
C_{13}	50μF 50V elect.
C_{14}	50μF 50V elect.
C_{15}	0.01μF 2,000V mica
C_{16}	0.01μF 2,000V mica

Valves

V_1	6SJ7M
V_2	6J5M
V_3	6SN7G
V_4	KT66
V_5	KT66
V_6	VR105/30

Miscellaneous

T_1	UM1 Woden
P_1	1MΩ pot.
P_2	100kΩ pot.

COMPONENTS LIST
(Power Supply)

Resistors

R_{21}	Brimistor Type CZ6, 3,000/30Ω
R_{22}	100kΩ 1W
R_{23}	100kΩ 1W
R_{24}	100Ω 1W
R_{25}	100Ω 1W
R_{26}	100Ω 1W
R_{27}	100Ω 1W

Condensers

C_{17}	0.01μF 750V
C_{18}	0.01μF 750V
C_{19}	4μF 600V paper
C_{20}	16μF 350V elect.
C_{21}	16μF 350V elect.

Miscellaneous

V_7	5U4G
T_2	400–0–400V C.T. 200mA 5V 3A 6.3V 3A (C.T. optional) 6.3V 5A (C.T. optional)
CH_1	10H 200mA
F_1	500mA fuse

The output stage is operated in class AB1, which means that the screen current fluctuates considerably with variations in input. Since this would result in a variation in screen voltage, V_6 is used for stabilization and provides a constant voltage drop of 105 volts regardless of the screen current variation. As the KT66 valves are operating near their maximum ratings, separate bias resistors are provided. The recommended anode-to-anode load for these valves is 8,000 ohms. The load resistance which will be imposed on the modulator by the transmitter PA valve can be found by dividing the PA h.t. voltage by the current; i.e. if the PA voltage is 600 and the current 100mA (one-tenth of an amp) then the load is 6,000 ohms. The transformer specified will, by virtue of its tapped primary and secondary, accommodate any impedance ratio likely to be required.

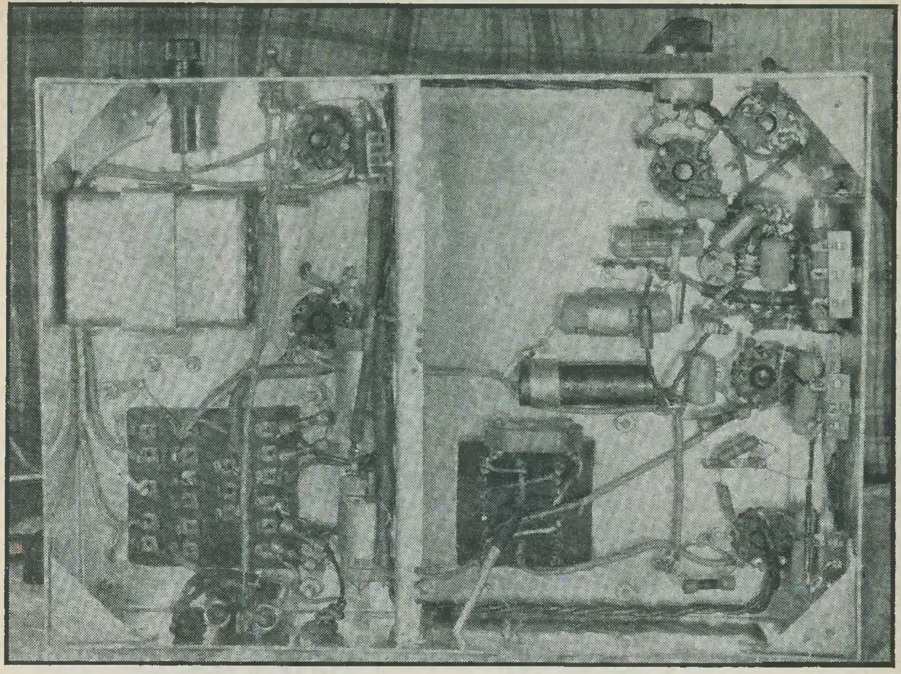
Two condensers C_{15}, C_{16} are used across the secondary of the modulation transformer. These not only reduce the unwanted high frequency response (one condenser would do this) but connected as shown also act as bypass condensers for any r.f. which may be fed back from the transmitter.

Power Supply

As shown in the photograph, this is built on the same chassis, and one or two points may be worthy of comment. In Fig. 2 resistors R_{24}, R_{25}, R_{26}, R_{27} are fitted to enable a centre-tapped heater supply to be available. If a transformer with centre-tapped heater windings is used these resistors will not, of course, be required. R_{21} is a Brimistor fitted for the protection of the filter condensers by limiting the voltage applied until the modulator is drawing current. C_{17}, C_{18} are r.f. filters. Additional smoothing is provided in the modulator itself and no hum troubles should be found.

Construction

The whole unit is built on a 14in x 10in x 2½in chassis with reinforced corners. The power supply components are screened from the others in the modulator section by a dividing plate which serves as a convenient mounting for some of the components, as shown. The screened microphone cable is connected direct to the grid of the first valve —a method which the writer adopted some



Underneath layout of 30-*watt modulator*

time ago to overcome the difficulties sometimes experienced in using an input jack. Unless the jack is absolutely screened, r.f. leaks into the first stage and it is far better to use co-ax connectors on the microphone end of the cable if required and thus avoid any possibility of trouble. As a further safeguard, all power supply wiring is carried out in screened wire.

In the modulator section the heaters are wired with tightly twisted 16 s.w.g. wire or heavy flex and run in the fold of the chassis as shown. The grid resistors R_{11}, R_{12}, R_{17}, R_{18} should be mounted on the valveholder tags to obtain the shortest possible leads. The rest of the layout is not very critical—the photographs show the layout used, which has not given any trouble either in construction, testing or operation. As a final screen some perforated zinc sheet of the kind obtainable at multiple stores was used as a bottom plate.

Testing

Before applying any power to the modulator (after all wiring has been checked) it is absolutely essential to place a load across the modulator transformer secondary. This may take the form of a resistor equal in value to the load impedance to be used, or more conveniently a 25-watt electric light bulb which will glow fairly brightly on a signal being applied to V_1.

If a 1,000 c/s tone source is available, this should be placed in front of the microphone. A useful alternative is a Morse Code practice oscillator, or buzzer. By connecting a pair of headphones between the grid of V_3 and chassis, the 1,000 c/s note or buzzer should be heard without any trace of hum. If there is any sign of hum it must be completely removed, or it will be passed on to the output stage for amplification.

P_2 is the phase inverter control mentioned previously, and the procedure for setting is as follows. The tone source is applied and an a.c. voltmeter, such as an AvoMeter on its 120-volt range, is connected from the grid of V_4 to chassis and the reading noted. A similar check is made on V_5, and P_2 should be adjusted until the readings are equal; the phase inverter is then balanced. No further adjustment will be required and the shaft of P_2 can be locked in position.

Conclusion

This modulator has been well proven in service for over two years, and no trouble of any kind has been experienced. Various amateurs have been kind enough to assist in on-the-air tests, some even making tape recordings of the transmissions, and their help is greatly appreciated.

a Selective medium wave tuner

By P. R TRAVERS

Although an f.m. tuner will provide all that is required in the way of reception of the three main B.B.C. programmes, there are occasions when there is a need for a tuner which will allow one to listen to one of the regional programmes of the B.B.C. or to one of the Continental stations. Constructors who, like myself, have built an f.m. tuner may be unwilling to invest in a new combined a.m.,/f.m. unit, and therefore there is a requirement for an a.m. tuner which will be relatively inexpensive to construct and which will be sufficiently selective to allow listening to musical programmes from the Continent. The unit to be described was designed to fulfil this need and to meet the following specification:

(i) To cover the medium wave band only since the Light programme can be received on v.h.f./f.m.

(ii) To provide reasonable selectivity with good signal-to-noise ratio.

(iii) To derive its power supply from an amplifier giving 350 volts h.t. at not more than 25mA and 6.3 volts at 2 amps centre-tapped to earth.

(iv) To be built on a chassis not more than 7in x 5in.

To meet these requirements a superhet circuit was decided upon; but, without a radio frequency stage the signal-to-noise ratio was found to be so poor that listening to Continental musical programmes at night was just not worth while. Difficulties with instability and the almost insurmountable problem of accommodating the necessary components on a small chassis led to the abandonment of a tuned r.f. and tuned frequency changer stages. An aperiodic r.f. stage coupled to a normal f.c. gave better results, but the final solution to the problem came when, on looking back through copies of *The Radio Constructor*, a circuit by S. E. Addis for a mains transportable was discovered in the January issue. This circuit uses a tuned r.f. stage resistance-capacity coupled to the frequency changer, and this technique has been used in the present tuner which is based extensively on Mr. Addis's circuit.

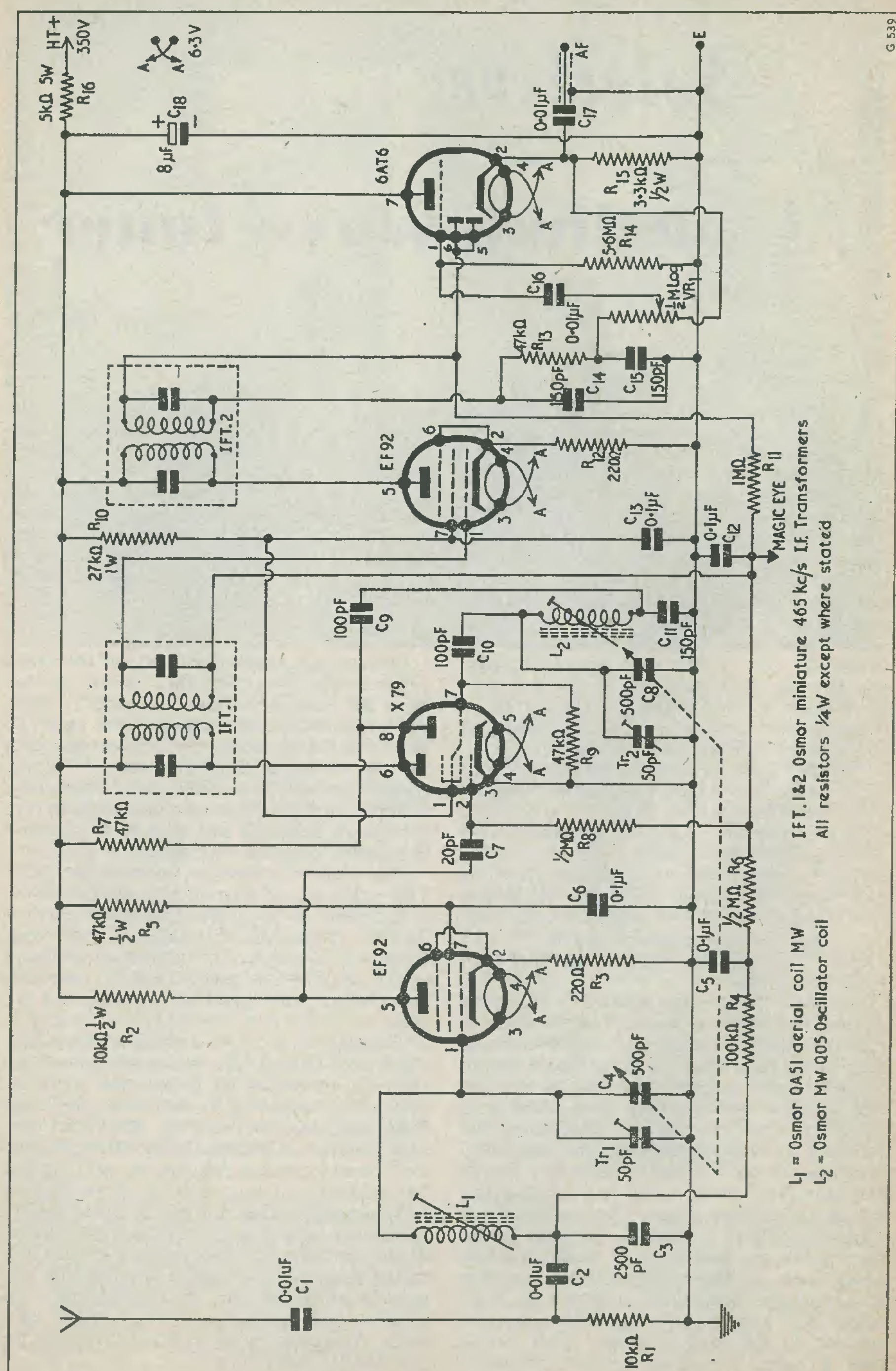
For a transportable radio a ferrite rod aerial is very convenient, but for a tuner which will be built into an amplifier cabinet the aerial's directional properties are a nuisance. The aerial circuit was therefore modified to use the Osmor "potted" coil.

The Circuit

Bottom end coupling is used for the aerial coil and a.v.c. is applied via a 100kΩ resistor from the main a.v.c. line. In order to keep the h.t. current consumption down an EF92 is used in the r.f. stage. No screening is used for this, or indeed any other, stage. The r.f. stage is coupled to the frequency changer by a 20pF capacitor as recommended in the previous article, and this method of coupling has given complete satisfaction.

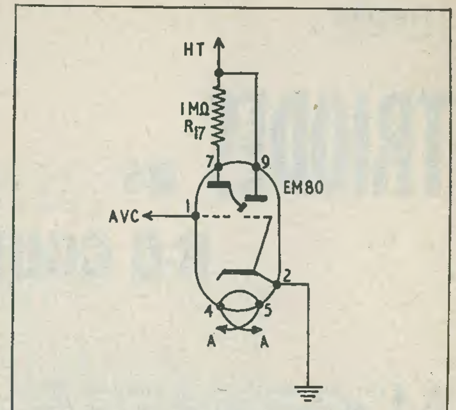
The frequency changer is an Osram X79. This valve has a separate cathode pin which is desirable as the heater line is not earthed directly. Otherwise this stage is quite conventional. Again, in the interest of economy of h.t., an EF92 is used as the i.f. amplifier and Osmor pre-aligned i.f. transformers are used.

The detector is a 6AT6 which also provides the a.v.c. voltage. The triode section of this valve is connected as a cathode follower, since it was necessary to use rather long leads from the tuner to the main amplifier. The gain control is retained, but owing to the unbypassed cathode resistor the gain cannot be reduced to zero; this is, however, no disadvantage as the control is retained merely to balance up the output of the tuner to that of the f.m. unit to allow switching from one to the other without undue fiddling with the gain control on the main amplifier. In practice this arrangement has worked very well. A simple tuning indicator is based on the EM80 "magic eye."



The following voltages were obtained using an AVO Universal Minor on the 1,000 volt range except for the cathode voltages when the 5 volt range was used.

Measuring point		*No signal conditions* Volts	*Strong signal* Volts
V_1	Anode	180	250
	Screen	160	240
	Cathode	1.4	0.6
V_2	Anode	240	250
	Screen	100	190
	Anode Osc.	90	100
V_3	Anode	240	250
	Screen	100	190
	Cathode	0.8	0.4
V_4	Anode	240	250
	Cathode	2.6	3



OPTIONAL TUNING INDICATOR

Construction

The unit was built on a chassis 7in x 5in x 2½in which allowed the miniature two-gang tuning capacitor to be mounted below the chassis. This gives a very "clean" above chassis appearance, and with the use of a horizontal dial assembly has kept the overall height of the unit down. The tuning indicator is mounted on the front "drop" of the chassis and is viewed through a hole cut in the dial panel. Tag strips were used for mounting the aerial capacitors and resistor, for the a.v.c. components, for the output filter and for anchoring the h.t. and heater leads. No difficulties were encountered in construction and, apart from keeping all leads as short as possible, no other precautions were taken to avoid instability.

The only test instrument available was a multi-range meter, and this proved quite adequate as the i.f. transformers are already aligned and need only the slightest adjustment. In the absence of a signal generator the unit was lined up on the Third Programme on 464 metres and Radio Luxembourg on 208 metres. The total h.t. consumption was found to be 20mA. The 5kΩ 5 watt resistor (R_{16}) reduced the available h.t. to about 248 volts, and would obviously need to be changed for different h.t. supplies.

With only an indoor aerial this tuner has proved most satisfactory and, used with a good quality amplifier and speaker system, allows one to listen to musical programmes from the Continent with considerable satisfaction. I would acknowledge with gratitude the help that I obtained from Mr. Addis's article on which the design of this tuner is very largely based.

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TRIODES as R-C COUPLED AMPLIFIERS

By V. T. ROLFE

Most readers will be familiar with the formula relating the load resistance and parameters of a valve with the gain that can be obtained in a practical circuit.

$$\text{Gain} = \frac{\mu R_a}{R_a + r_a}$$

where μ is the amplification factor of the valve, r_a is the anode impedance of the valve, and R_a is the load resistance.

When designing an amplifier and considering the use of various valves with different values of anode load, much work can be saved by using the graph shown here.

The upper right-hand quadrant relates the three valve parameters μ, r_a and g_m. If two of these are known, the third can be read off directly. The scales cover all values normally encountered with triodes. As an example, it will readily be seen from the graph that a valve with a g_m of 1.5mA/V having a μ of 60 will have an anode impedance of 40kΩ.

The most important parameter for a voltage amplifying triode is μ. It will be seen from the above expression that if $\frac{R_a}{R_a+r_a}$ could be made equal to 1, the gain of the stage would be equal to μ. Thus it will be realised that since $\frac{R_a}{R_a+r_a}$ can never exceed 1, μ is the maximum or "ceiling" value of the stage gain.

The fraction $\frac{R_a}{R_a+r_a}$ in the above expression merely determines what percentage of this ceiling value can be obtained. It will readily be seen that if R_a is equal to r_a, the gain of the stage is $\frac{\mu}{2}$. As the load R_a is increased, the gain is increased and in practice gains of up to about 70% of μ can be obtained.

The second part of the graph, the lower right-hand quadrant, resolves the fraction $\frac{R_a}{R_a+r_a}$. Curves have been plotted for values of load resistance (R_a) from 10kΩ to 220kΩ, this being the range of values usually encountered in resistance-capacity-coupled amplifiers. It will also be noticed that these curves are based on standard resistance values. The vertical axis of this part of the graph could be marked in percentage, starting at the origin and proceeding downwards, each large square being equivalent to 20%, the lowest line representing 100%.

The final quadrant of the graph serves merely to multiply the percentage obtained from the last quadrant by the actual μ of the valve, to give the stage gain (V.A.F.). The values of μ are represented by the sloping lines, and as in the first quadrant, values up to 100 are accommodated. The final answer, the stage gain, is read off along the horizontal scale immediately below the circuit diagram.

To demonstrate the use of the graph in a practical case, the following examples may be of interest:

(1) One section of an ECC83 (μ=100, g_m=1.25mA/V) is to be used with a 100kΩ load resistor. What will the stage gain be?

1st Quadrant. The line corresponding to g_m=1.25mA/V will come midway between the 1 and 1.5 lines on the graph, and will cut the μ line at a point corresponding to r_a=83kΩ.

2nd Quadrant. Projecting this value downwards on to the R_a=100kΩ line gives a point (corresponding to 54% approx.) which can then be projected across the page and into the third quadrant.

3rd Quadrant. The interception of this projection with the μ=100 line will give a voltage amplification factor of 54.

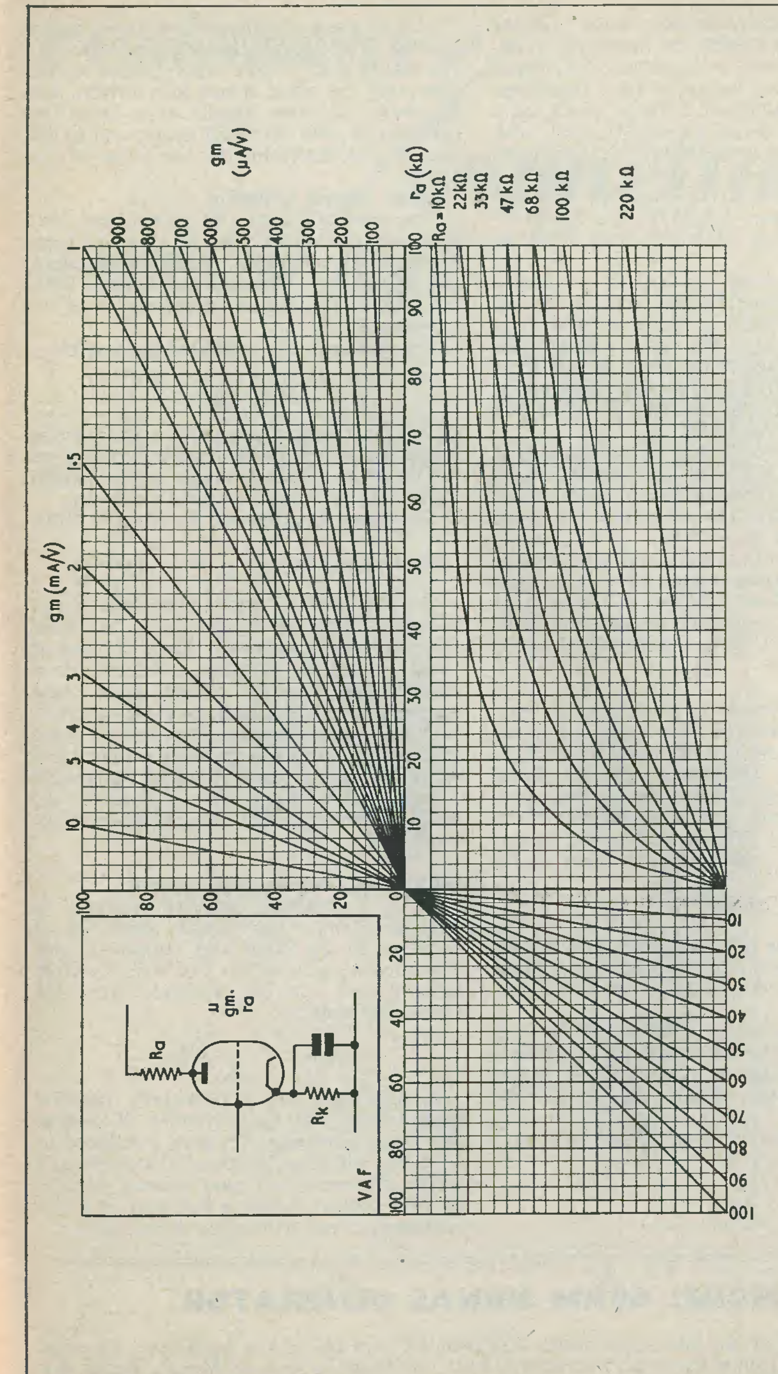


CHART FOR DETERMINING GAIN OF TRIODE USED AS R-C COUPLED AMPLIFIER

The manufacturer's data sheet for the ECC83 gives a number of operating conditions for the valve at various line voltages, and with various values of load resistance. With an h.t. voltage of 250V (at which the μ and g_m used were measured), and with 100kΩ load, the manufacturer's tables quote a gain of 54.5.

(2) A gain of 30 is required from an EBC41 (g_m=1.3mA/V, r_a=54kΩ). What value of anode load must be used?

Since the answer required is the anode load, this must be obtained from the second quadrant. The value of r_a can be used along the horizontal axis, the vertical component must be computed in the third section from the V.A.F. required (30 in this case) and μ, which can in turn be obtained from the first quadrant by using g_m and r_a.

In this case, μ is 70 and the interception of this and the V.A.F.=30 line must be traced across into the 2nd Quadrant, and plotted against r_a=54kΩ. The resultant lies between R_a=33kΩ, and R_a=47kΩ.

In a case such as this it would be advisable to take the higher value. A quick check across to the 3rd Quadrant will show that this will give a slightly higher gain (33), whereas the lower value of 33kΩ will give a gain of about 28.

Cathode Bias Resistor

Having determined the value of load required, it will next be necessary to calculate the value of R_k. The correct method of doing this is to get the I_a/V_a curves for the valve, draw in the load line, and determine the operating point. The value of I_a and V_g can then be used to determine the value of R_k $\left\{=\frac{V_g}{I_a}\right\}$.

In the absence of valve curves, this cannot of course be done, but the following method will give some idea of the value to be employed:

Divide the value of load used by the stage gain. The result will give (approximately) the value of R_k to be used. In the examples given already the values obtained by this method are $\frac{100}{54}$=1.8kΩ, and $\frac{47}{30}$=1.56kΩ.

In the former case the manufacturers quote a value of 1.5kΩ, so the answer obtained by this means is 20% high. This will not matter providing the stage is not fully driven, but for more accurate results tests must be carried out with an oscilloscope and audio oscillator to determine the best value of R_k.

Cathode Bypass Capacitor

The value of C_k must be chosen such that it adequately bypasses R_k at all frequencies likely to be encountered. The high frequency end of the band presents no problem here, but the low frequency response must be considered.

The reactance of a capacitor is given by:

$$X_c=\frac{1}{2\pi fC}$$

This must be small compared with R_k at the lowest frequency to be considered, and we can therefore consider the frequency at which R_k and X_c are equal as a reference point.

The above equation can therefore be transposed to give $C_k=\frac{1}{2\pi f R_k}$ or $f=\frac{1}{2\pi C_k R_k}$.

If f=30 c/s, and R_k=1,000Ω, the corresponding value of C_k is 50μF. If linear response is required below 30 c/s, a value of 100μF would be necessary, whereas for a small radio receiver where good bass response is not required, a value of 25μF would be quite adequate. It should be noted that the value of C_k is inversely proportional to R_k. Thus if a higher value of R_k is used, a lower value of C_k will be necessary to maintain the frequency response down to the same level.

Unbypassed Cathode Bias Resistor

If C_k is omitted, negative feedback is introduced into the circuit since R_k is common to the input and output circuits. The effective gain of the circuit is therefore reduced and can be calculated from the following formula:

$$\text{Gain}=A.\frac{R_a}{R_a+A.R_k}$$

A represents the gain without negative feedback (i.e. with C_k in circuit). If R_k is as calculated previously, the gain is reduced by 50%. It will also be found that high gain stages will have their gain severely reduced by this method, whereas the gain of a low gain stage is not reduced so drastically.

MODEL 68AM SIGNAL GENERATOR

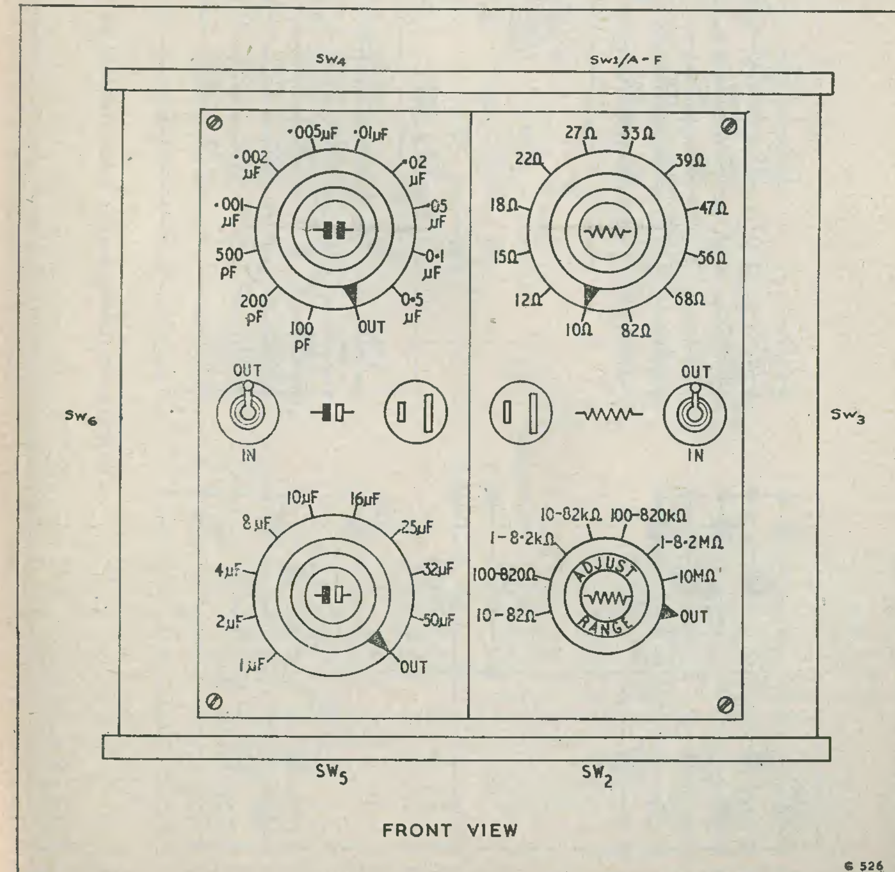
In the review of this instrument which was given on page 661 of the April issue, the name of the makers, Taylor Electrical Instruments Ltd., of Montrose Avenue, Slough, Bucks, was regrettably omitted.

resistance/capacitance SUBSTITUTION UNIT

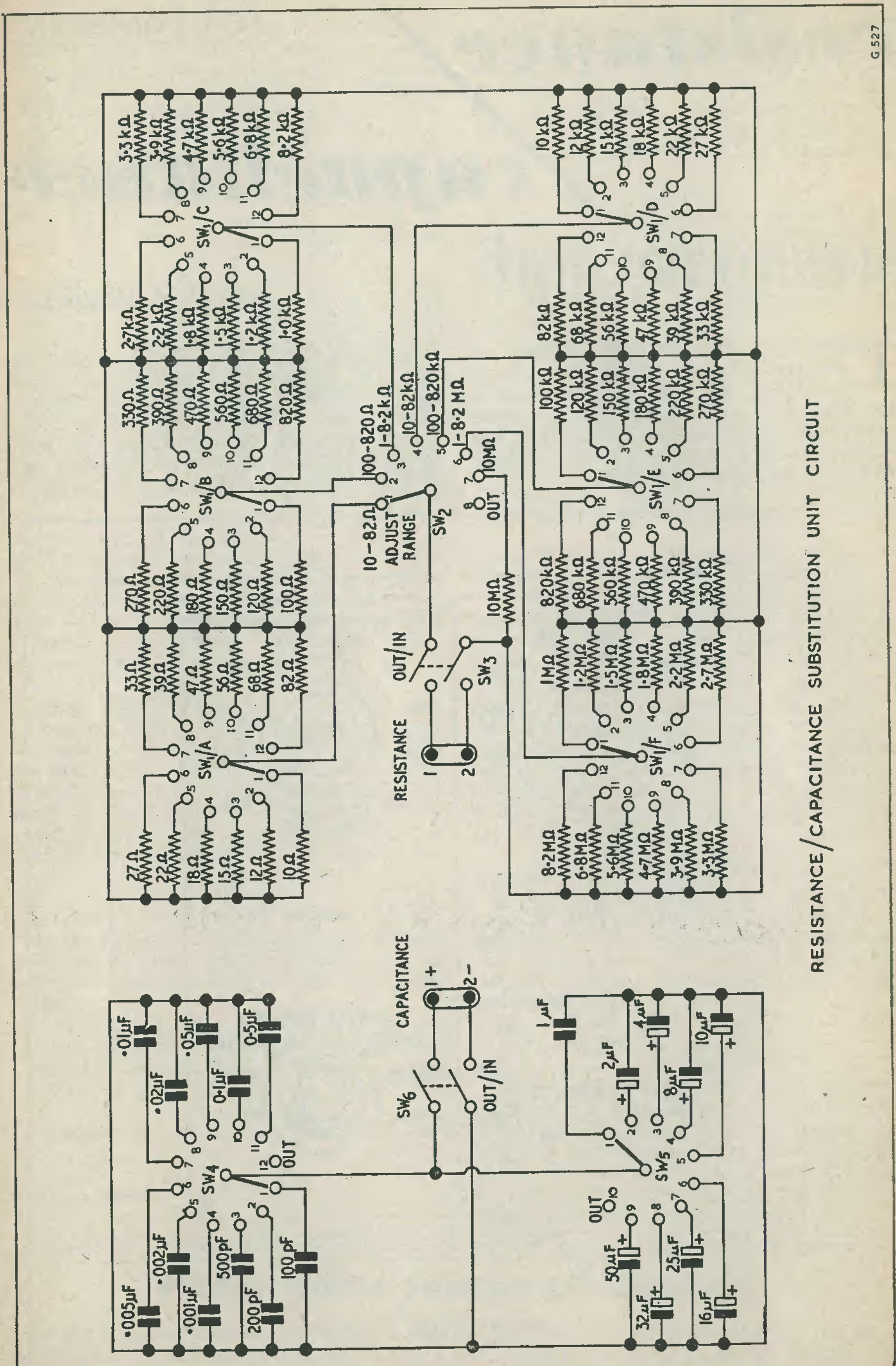
By M. A. HAMMOND

There have been many variations of this type of unit over the years, but it is felt that this version, covering as it does the full 10% preferred range of resistors and the more useful range of capacitors, will appeal to the constructor particularly because of its ease of operation.

Referring to the circuit, it will be observed that the appropriate resistor decade is selected by SW_2 and the appropriate preferred value within that decade selected on SW_1. It will, therefore, be appreciated that with the manipulation of these two switches any 10% preferred value of resistor is "on tap"



FRONT VIEW



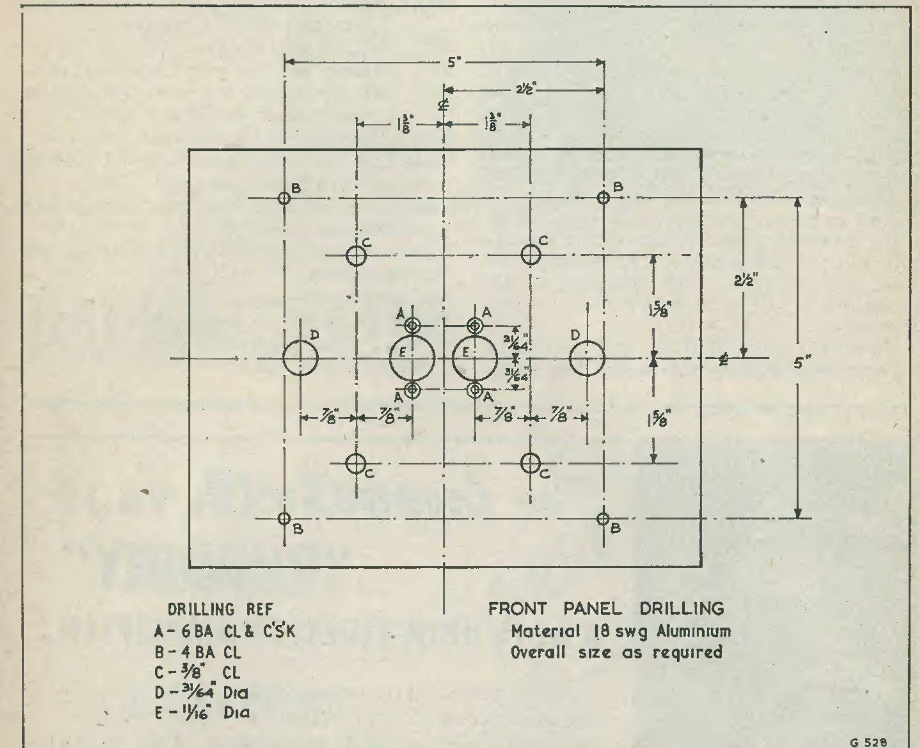
RESISTANCE/CAPACITANCE SUBSTITUTION UNIT CIRCUIT

at the output plug when SW_3 is at the "IN" position. It will also be observed that the 10MΩ value is selected with SW_2 only.

For the capacitors a slightly different method is employed, splitting the two ranges over two switches SW_4 and SW_5, the capacitance required being selected on the appropriate switch with the other switch range of course being turned to the "OUT" position. If this is not done, the resultant capacity "on tap" will be a parallel of the capacitances indicated by the switches.

top and bottom hinged, thereby making the final wiring accessible. Unfortunately, I cannot remember the type number of the unit that originally was housed in this case, but they are still available for a few shillings in the favourite haunts of constructors off Leicester Square Station in London, and can probably be found in other parts of the country where there are shops catering for ex-Government equipment.

A new front panel was all that was required, and any large holes left by the



It is therefore apparent that with appropriate leads from the plugs, any combination of resistance and/or capacitance can be injected to any equipment under test, thereby avoiding the tedious business of substitution and re-substitution until the desired result is achieved.

Furthermore, if one cares to use a close tolerance selection of resistors at any position of the ranges, this unit will prove invaluable for calibration purposes.

The writer's own unit was constructed some years ago and is housed in an ex-Government battery amplifier case measuring 8in x 7in x 6in approximately, which had its removal of the original contents were blanked off and the whole case given a new coat of paint. The scales were drawn out on a thin piece of white card 5½in x 5½in, taking care to line up with the panel drillings (see drilling diagram) with appropriate holes cut to clear the rotary switches' fixing nuts, the toggle switch mounting bushes and, of course, the plugs.

The scale is held in position by a same sized panel of ⅛in clear Perspex with corresponding holes and secured to the front panel by four screws. This presents a very neat appearance and the scale remains legible and clean.

The symbols, etc., shown on the knobs were hand-written with aluminium paint and a fine mapping pen direct on to the black surface of the knobs. This method has proved extremely durable, and even more so with the application later of a little clear varnish.

Care must be taken with the wiring to avoid mistakes, and here it is advisable to use a range of coloured flexibles for each common value on SW_1, wiring up each wafer in turn, starting from the switch mechanism.

The resistors and capacitors were pre-wired on tagboards and deployed around the sides of the case, use also being made of the bottom hinged portion for the larger capacitors with appropriate "flying" cableform to the switches. The wiring was laced as each section was completed, and although the number of solder joints seemed endless, it was found well worth the trouble spent during the many uses of the unit since its completion.

This unit can be simplified as required by using a smaller range of resistors or capacitors, but if one can extract the range shown from his "spares" with possibly a few purchases, it will be found to be well worth the outlay.

For the benefit of those not conversant with preferred resistor values, the table given here shows the nominal values obtainable in each of the three tolerance ranges $\pm 20\%$, $\pm 10\%$ and $\pm 5\%$.

One further point—it is preferable to use resistors in this unit rated at ½W or higher, and also the higher working voltage types of capacitors, to avoid any "burn-ups" when using the unit.

Component List for Circuit Shown

SW_{1A-F} Rotary 6 wafer switch assembly, each wafer 1-pole 12-position
SW_2 Rotary switch 1-pole 12-position (stopped off for 8 positions)
SW_3 Double-pole toggle switch
SW_4 Rotary switch 1-pole 12-position
SW_5 Rotary switch 1-pole 12-position (stopped off for 10 positions)
SW_6 Double-pole toggle switch
Capacitors as indicated on circuit (working voltages as required)
Resistors as indicated on circuit (wattage and tolerance as required)
2 2-way chassis plugs (Painton miniature) and cable sockets
4 suitable knobs
Tagboards, wire, etc., as required
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20P1	12/-	6SJ7	7/6	UY41	7/6	1R5	7/6
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★ **ALL NEW COMPONENTS—AVAILABLE SEPARATELY OR IN COMPLETE PACK**

First and best DO-IT-YOURSELF Car Radio. Uses new Brimar low volt. valves, no vibrator. Printed circuit and power transistor. Negligible "fade" and no "buzz." Only 1.5 amp consumption. Complete with chassis assembly, filter box and output stage including elliptical loudspeaker and detailed instructions.

Can be built for £13.10.0 *plus 5/- p. & p.*

(See page 598 March issue)

Cash with order or write for BUY-AS-YOU-BUILD details

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Telephone **Bywood 1263**

NOW! THE TouRiSt PORTABLE

light-weight Battery Radio. Size only 8" x 5½" x 4", weight 3½lb.

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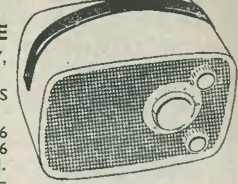

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5" Speaker and o/p Trans.	**21/-** p. & p. 1/6
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T*ERRIFIC PERFORMANCE* — **R***EMARKABLE SIZE* — **S***TAGGERING VALUE*

COMPLETE KIT ONLY £6.8.6 Post Free
Latest circuitry, A.V.C. and neg. feedback. Instruction Booklet 1/6 (Free with Kit)

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All Brand New and Latest 4-sp. Models

SINGLE PLAYERS. B.S.R. (TU9) **92/6**; Collaro (4/564) **6 gns.**; Garrard (4SP) **£7.15.0**; Garrard (TA Mk 2) **£9.5.0.** Carr and ins. 3/6.

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Log. or lin. ratios, 10,000 ohms–2 Megohms. Long spindles. 1 year guarantee. Midget Ediswan type, 1⅛" dia. No sw. 3/-, d.p. sw. **4/9.**

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Latest push-pull 4-transistor circuit giving full 1 watt output. Neg. feedback, vol. and tone controls with improved sensitivity and freq. response. Chassis size 6¾" x 3¾" x 1½". Current consumption 10mA quiescent—250mA at 1 watt.

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6V battery operated. Light-weight Xtal P.U. with twin sapphire styli (one spare) auto stop. Mounting 7½" x 6". Attractive continental styling—ideal companion unit to above amplifier.
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CAR RADIO KIT. This popular Hybrid printed circuit 12V Car Radio as currently featured in *The Radio Constructor* is shortly available.
Complete Kit incl. Speaker **ONLY £12.19.6** P. & P. 3/6

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Low Loss Semi-Air Spaced AERAXIAL.
SPECIAL REDUCED PRICES
20 yds **12/6**, p. & p. 1/6; 40 yds **22/6**, p. & p. 2/-; 60 yds **32/6**, p. & p. 3/-. All other lengths **8d.** yd.
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New improved types—mains prim. 200/250V tapped

All isolation transformers now supplied with alternative no boost plus 25%, and plus 50% boost taps, at no extra charge.

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SPECIAL 1R5, 1T4, 1S5, 3S4 or 3V4 per set, **27/6.** DK96, DF96, DAF96, DL96, **35/-**. 6K8, 6K7, 6Q7, 6V6, 5Z4 or 6X5, **35/-.**

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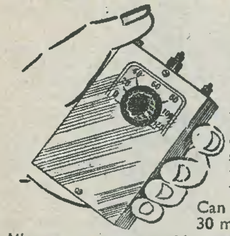
Any parcel insured against damage in transit for only **6d.** extra per order. All uninsured parcels at customer's risk.

C.O.D. or C.W.O. only. S.A.E. with enquiries. Postage and packing **6d.** per valve extra. Over £3 FREE. *Trade enquiries invited.*

RADIOSETTE



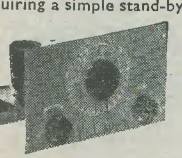
The ideal low cost transistor pocket radio for the beginner. The circuit utilises the new R.C.S. VARILOOP-STICK transistor coil. A specially designed miniature .0004 tuning condenser permits the set to be in a case which fits the palm of your hand.

Can be built in 30 minutes **30/-**

All components are sold separately, full construction data including plan of parts, 2/-

ALL-WAVE RADIO **35/-**

Ideal for the beginner or for those requiring a simple stand-by receiver



This 1 valve S.W. receiver can be built for 35/- from our list of components, which can be purchased separately. It includes valve and 1 coil covering 20–40 metres. Provision is made to increase to 2 or 3 valves if required, and all components are colour-coded so that the beginner can build this set quite easily. *Send 2/- for specification, wiring diagram, layout and price list.*

Postage: Under 10/-, 9d.. Under 40/-, 1/6 Over 40/-, post free

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The Teletron TRANSIDYNE

Portable 6-Transistor Superhet Receiver with printed circuit

Circuit diagram with instructions available from most advertisers in this magazine, 1/- post free

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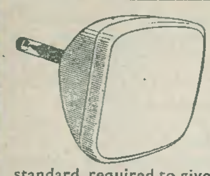


REPLACEMENT REBUILT TV TUBES £8/10/0

12 months full guarantee

All sizes and types except 10". Rebuilt to the high standard required to give a long picture life, quality and value. Carr. and ins. 15/6.

We are also able to offer attractive terms on the above as follows: 8/6 initial payment and 19 weekly repayments of 8/6.

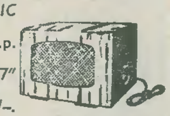
★ FAMILY RADIO £6/10/0

5-valve (octal) superhet. A.C 3 waveband and gram. position. 4 controls. Modern attractive cabinet size 15¼" x 18" x 10½" in cream and brown. Carr and ins. 8/6.

★ EXTENSION SPEAKERS 19/9

Polished oak cabinet of attractive appearance. Fitted with 8" p.m. speaker, W.B. or Goodmans, of the highest quality. Standard matching to any receiver (2-5 ohms). Switch and flex included. Ins. carr. 3/6.

IDEAL FOR STEREOPHONIC SOUND!



8" p.m. Speakers 8/9 With o.p. transformer fitted, 10/-.
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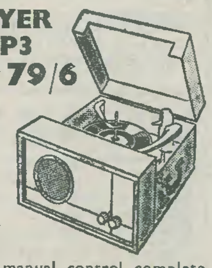
8" x 5" Elliptical Speakers 22/-. P. & P. 2/9.

RECORD PLAYER CABINET RP3 79/6



A delightful looking cabinet 14¾" x 17¾" x 8¾" in two-tone leatherette. Will take a B.S.R. Monarch 4-speed autochanger and 6½" round speaker. Carr. and ins. 4/6.

B.S.R. MONARCH 4-SPEED AUTO-CHANGER ... £6.19.6
Incorporating auto and manual control complete with turnover crystal p.u. and sapphire stylus.
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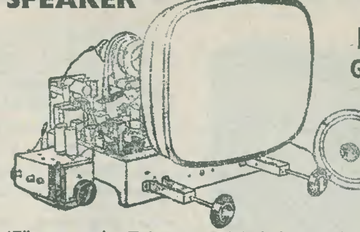
PORTABLE AMPLIFIER MARK D.1 59/6
12 months guarantee
Brand new. Latest design with printed circuit. Dimensions 7" x 2¼" x 5". A.C. only. Mains isolated. 2-3 watts output. Incorporating EL84 as high gain output valve. Volume and tone controls. Knobs **2/6** extra. P. & P. 3/6.

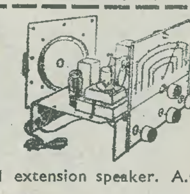
17" TV CHASSIS, TUBE AND SPEAKER



16 GNS.

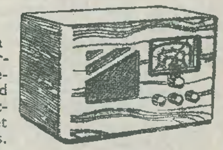
17" rectangular Tube on modified chassis. Supplied as single channel chassis covering B.B.C. channels 1-5, or incorporating Turret Tuner, which can be added as an extra, at our special price to chassis purchasers of 50/-, giving choice of any 2 channels (B.B.C. and I.T.A.). Extra channels can be supplied at **7/6** each. Chassis size 12" x 14½" x 11" less valves. Similar chassis are used by well-known companies because of their stability and reliability. With tube and speaker (less valves) **16 guineas.** Complete and working with valves and turret tuner **24 guineas.** 12 months guarantee on the valves and chassis. Ins. carr. (incl. tube) 25/-.

SUPER CHASSIS 99/6



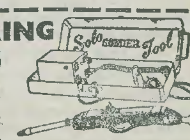
5-valve superhet chassis including 8" p.m. speaker and valves. Four control knobs (tone, volume, tuning, w/change switch). Four w/bands with position for gram. p.u. and extension speaker. A.C. Ins. carr. 5/6.

HOME RADIO 79/6



A.C./D.C. Universal mains 5-valve octal superhet 3 waveband receiver. Can be adapted to gram. p.u. In attractive wooden cabinet 9¾" x 18½" x 11¾". Ins. carr. [illegible]/6.

SOLO SOLDERING TOOL 12/6



110V, 6V or 12V (special adaptor for 200/240V **10/-** extra). Automatic solder feed including a 20 ft. reel of Ersin 60/40 solder and spare parts. It is a tool for electronic soldering or car wiring. Revolutionary in design. Instantly ready for use and cannot burn. In light metal case with full instructions for use. Post 2/9.

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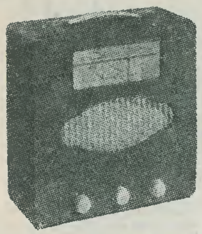

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★ FIVE VALVE SUPERHET
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★ ALL MARCONI VALVES
★ SLOW MOTION TUNING
★ 7" x 4" ELLIPTICAL SPEAKER
★ GRAM. PICK-UP SOCKETS
★ CHASSIS SIZE 10" x 10" x 4"
★ MAINS 200/240V A.C./D.C.

£7.12.6 Post 5/- (BOTH MODELS)

PORTABLE POLISHED WOOD CABINET, 27/6 EXTRA

SUPER REXINE PORTABLE CABINET (Illustrated) 37/6 EXTRA

The ideal unit for a radio-gram or portable radio

Models available:

Type C
Medium wave, 180 to 550 metres
Short wave, 10 to 90 metres (3 to 30 Mc/s) in two wavebands

Type D
Medium wave, 180 to 550 metres
Long wave, 800 to 2,000 metres
Short wave, 15 to 50 metres (6 to 20 Mc/s)

NEW RECORD PLAYERS

Collaro Conquest. The latest 4-speed autochanger with lightweight turnover crystal pick-up. Brand new and guaranteed **£7.19.6** P.P 4/6

Garrard 4-speed single player with latest turnover crystal pick-up. Brand new and guaranteed. **£6.19.6** P.P 3/6

B.S.R. Monarch. The latest version of this well-known 4-speed autochanger with turnover crystal pick-up **£6.19.6** P.P. 4/-

AC/DC 200/250V PORTABLE-GRAM AMPLIFIER

Completely assembled on baffle board size 12¼" x 4¾", depth 3". Containing two Mullard valves type UL84 and UY85. Elac 7" x 4" elliptical speaker, volume control, tone control. Nothing else to buy, just plug in to mains and connect your pick-up to amplifier.

67/6 Carr. 2/6

CRYSTAL MIC. INSERTS

¾" square	3/6	1½" round (Acos)	7/6
¾" round (Acos)	5/-	2" round (Acos)	12/6

Each item p.p. 6d.
Suitable moulded plastic hand mic. case 2/6 p.p. 1/-

TRANSMITTER/RECEIVER
Army Type 17 Mk. II

Complete with Valves, High Resistance Headphones, Handmike and Instruction Book and circuit. Frequency Range 44.0 to 61 Mc/s. Range approximately 3 to 8 miles. Power requirements: Standard 120V h.t. and 2V l.t. Ideal for Civil Defence and communications BRAND NEW **45/-**
44–61 Mc/s calibrated wavemeter for same, 10/- extra

WALKIE/TALKIE TYPE 38 TRANSMITTER/RECEIVER

Complete with 5 valves. In new condition. These sets are sold without guarantee, but are serviceable. **22/6** P.P. 2/6

Headphones 7/6 pair, Junction Box 2/6, Throat Mike 4/6, Canvas Bag 4/-, Aerial Rod 2/6

373 MINIATURE I.F. STRIPS 9.72 MC/S

The ideal f.m. conversion unit as described in *P.W.*, April/May 1957. Complete with 6 valves, three EF91s, two EF92s and one EB91. I.F.T.s, etc., in absolutely new condition. With circuit and conversion data.

12/6 (less valves) **37/6** (with valves)
Postage and packing 2/6 (either type)

VIBRATOR PACKS. Input 6V d.c. Output approx. 100V d.c. at 30mA, fully smoothed and r.f. filtered. Size 6½" x 5" x 2". Fitted with Mallory 629C vibrator. BRAND NEW. Boxed. 12/6, p.p. 1/6

PACKARD-BELL PRE-AMP. Complete in screened case with 6SL7GT; 28D7 relay; leads, jack plug, etc. Handbook. Sealed in carton ONLY **12/6** P.P 2/-

RCA 6½" 3-ohm P.M. SPEAKER in Cabinet. With volume control and 600 ohm line trans. **27/6** P.P. 2/6

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TYPE 25 Switched. Tuning 30 to 40 Mc/s. includes 3 SP61s Carriage 2/6 **10/-**
TYPE 26. Variable tuning, 50 to 65 Mc/s. including 2 EF54s and EC52. Carr. 2/6 **25/-**
(Circuits in stock for both types 9d.)

ROTARY CONVERTER

24V d.c. to 230V a.c. 50 cycles. 100 watts. Brand new and unused. **£5.10.0** Carr. 7/6

QUARTZ CRYSTALS

A large range of frequencies in stock from 100 kc/s upwards. Fundamentals: 54th and 72nd harmonics, etc. **Send for NEW free complete list.**

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NEW BARGAIN PARCEL

★ Perdio style moulded cabinet with gold trimmings (red, blue or cream) 12/6
★ J.B. 208+176pF screened gang 10/6
★ Miniature 2½" 3 ohm speaker 21/6
★ 20:1 output transformer 10/-
★ 5-transistor printed circuit 5/6
★ 5-transistor circuit diagram 1/-
★ Cabinet size 5¼" x 3¼" x 1½"

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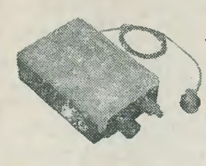

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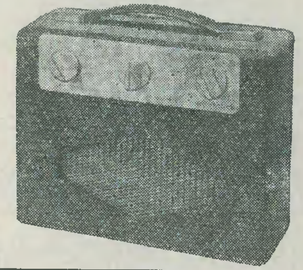

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